Clinical Decision Making in Colorectal Surgery

Scott R. Steele
Justin A. Maykel
Steven D. Wexner
Editors

Second Edition

Springer

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The first edition of Clinical Decision Making in Colorectal Surgery was dedicated to my dear friends and deeply appreciated philanthropic supporters the Caporella family and their company, the National Beverage Corporation. It is only fitting that 25 years later I again dedicate the second edition to Nick Caporella, Joe Caporella, and the National Beverage Corporation for their three decades of unparalleled support to the research and education activities of the Department of Colorectal Surgery at Cleveland Clinic Florida. Without their shared altruistic vision and tremendous financial commitment to our programs, our department would not be where it is today.

—Steven D. Wexner

Foreword

It is a pleasure and an honor to be asked to write the foreword for the second edition of a book that was initially published in 1995. At the time the book represented a unique approach to a wide variety of colorectal and anal conditions; by providing thoughtful and organized algorithms for each topic, the reader was provided with the essentials required for the evaluation of each entity. To their credit, the editors of the second edition, all of whom are internationally known academic clinicians in the field of colorectal surgery, have realized the value of this format and preserved it in this new iteration.

The authors of each of the chapters are practicing physicians and surgeons who convey a logical clinical approach to the specific problem they are addressing. Many of the contributors are accomplished and respected teachers within their specialty. Individual chapters are brief but sufficient. References are current and supportive of the points made in each chapter while not being overwhelming in number. Under no circumstances should this book be considered an encyclopedic reference textbook; rather, the chapters form a sound basis for more exhaustive reading on any of the presented topics.

It has long been my advice to individuals preparing for the certifying (oral) examination of the American Board of Colon and Rectal Surgery to review each subject and prepare an algorithm that reflects current practice for each of the diseases that we see and treat. The current edition of this book makes the task much easier for the examinee. In fact, with the near doubling of medical information every three months this is a book that should be readily available not just to colorectal surgeons but to anybody who cares for patients with colorectal diseases, since it will provide concise and cogent direction to evaluation and treatment of a broad array of relatively common and uncommon diseases in a rapidly changing landscape. The editors should be congratulated for creating a text that can be so valuable for so many.

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Preface

Second Edition Clinical Decision Making

Twenty-five years have elapsed since the publication of the first edition of *Clinical Decision Making in Colorectal Surgery* by Steven D. Wexner and Anthony M. Vernava III. That textbook served many trainees and practicing surgeons quite well for rapid review of the current evaluation and management of individual problem-based questions. The algorithmic approach was found to be very clinically relevant and practical. The combination of clarity, brevity, and references was greatly appreciated. Accordingly, many times during the last 25 years surgeons have asked for second updated edition. Thus, we are delighted to present this long-awaited second edition to the surgical community. The second edition of *Clinical Decision Making in Colorectal Surgery* has added many topics, updated content in every single area, subdivided chapters in which more detailed information has been accumulated, and has in every instance, recruited renowned global leaders in colorectal surgery to share their expertise and present the best evidence-based practice algorithms to readers. We are very proud to present to you this comprehensive volume and deeply appreciate the 183 chapter authors who have expended considerable time and delivered superlative expertise with each assignment. We thank all of our colleagues and friends for their efforts that have culminated in the production of this outstanding volume.

We are both optimistic and confident that you will enjoy and frequently rely upon this algorithmic textbook *Clinical Decision Making in Colorectal Surgery*.

Cleveland, OH — Scott R. Steele
Worcester, MA — Justin A. Maykel
Weston, FL — Steven D. Wexner

Acknowledgments

My sincere gratitude for our incredible, hardworking, and talented Developmental Editor Elektra McDermott. I would also like to thank all the authors for their outstanding content and my co-editors, Steve and Justin, for their insight, skill, and collaboration. Finally, to my family Michele and Marianna as well as Piper and Flynn for their continued patience and support behind the scenes.

Scott R. Steele

I would like to thank the individual authors for their commitment to this textbook and for the time they dedicated to bring our readers the most comprehensive and up-to-date review of the topics. I would also like to thank my co-editors for their leadership and diligence thought the production process. Finally, I would like to thank our patients who provide us with our inspiration.

Justin A. Maykel

I am grateful to Ms. Elektra McDermott for her time and talents as both our development and copy editor. I would like to also thank Debbie Holton for her assistance to the editors at all stages of conception, creation, and production of this volume.

Steven D. Wexner

Contents

Part I Evaluation and Perioperative

1 **Anorectal Examination** 3
Nilam D. Patel, Scott R. Steele, and Emily Steinhagen

2 **Anorectal and Colonic Evaluation** 7
Jason S. Mizell and Kaitlin Domek

3 **Physiologic Testing** 13
Kirsten Bass Wilkins and Joseph R. Notaro

4 **Mechanical Bowel Preparation for Elective Colon and Rectal Surgery** 25
Chaya Shwaartz and Oded Zmora

5 **Perioperative Assessment and Risk Stratification** 37
Debbie G. Bakes and Laurence R. Sands

6 **Enhanced Recovery Pathways in Colorectal Surgery** 45
Sherief Shawki, David Liska, and Conor P. Delaney

7 **Hematochezia and Melena** 55
Anjali S. Kumar and Jennifer Ayscue

8 **Anal Disease in the Neutropenic Patient** 65
Margaux N. Mustian and Melanie S. Morris

9 **Evaluation and Perioperative: Anal Mass** 71
Robert A. Malizia and Brian T. Valerian

Part II Anal Conditions

10 **Anal Conditions: Anal Fissure/Recurrent Anal Fissure** 81
Alexandra Elias and Ron G. Landmann

11 **Anal Conditions: Anal Stenosis and Stricture** 87
Shafik M. Sidani and Maher A. Abbas

12 **Anorectal Abscess** 95
Zhaomin Xu and Jenny R. Speranza

13 **Anal Conditions: Fistula-in-Ano** 101
Sebastien Lachance and Marylise Boutros

14 Anal Conditions: Rectovaginal Fistula 111
Jennifer E. Hrabe and Tracy L. Hull

15 Anal Conditions: Anorectal Crohn's Disease—Fistula 125
Andrew T. Schlussel and Karim Alavi

16 Anorectal Crohn's Disease: Anal Stenosis and Anal Fissure . . . 135
Jeanette Zhang and Howard M. Ross

17 Management of Internal Hemorrhoids 141
Allison Weaver and Scott R. Steele

18 Anal Conditions: External Hemorrhoids 145
Michael Sigman and Dana Hayden

19 Anal Conditions: Pilonidal Disease/Complex and Recurrent Pilonidal Disease 151
Richard S. Hoehn and Ian M. Paquette

20 Anal Conditions: Pruritus Ani 159
Brian L. Bello and Konstantin Umanskiy

21 Anal Conditions: Hidradenitis Suppurativa 169
H. Hande Aydinli and Emre Gorgun

22 Anal Conditions: Anorectal Trauma 179
David M. Schwartzberg, Mitchell A. Bernstein, and Alexis L. Grucela

23 Anal Conditions: STDs 183
Cindy Kin

24 Anal Considerations: Fournier's Gangrene 189
Vanessa W. Hui and Rahul Narang

25 Non-healing Perineal Wounds 195
Joshua H. Wolf and Martin Newman

26 Anal Intraepithelial Neoplasms 201
Alexis R. Harvey and Scott R. Steele

27 Anal Conditions: Anal Margin Tumors 207
David A. Vivas and Jill C. Genua

28 Invasive Anal Canal Neoplasia 213
David M. Schwartzberg and Michael J. Grieco

Part III Pelvic Floor

29 Pelvic Floor Conditions: Rectal Prolapse/Recurrence 219
Christopher R. Dwyer and Dipen C. Maun

30 Pelvic Floor Conditions: Rectal Intussusception 229
Earl V. Thompson IV and Nicole M. Saur

31 Pelvic Outlet Obstruction 237
Jennifer S. Davids

32 Pelvic Floor Conditions: Biofeedback 245
Jennifer S. Beaty and Charles A. Ternent

33 Pelvic Floor Conditions: Fecal Incontinence 255
Mary T. M. O'Donnell and Joshua I. S. Bleier

34 Pelvic Floor Conditions: Diarrhea. 265
Rebecca Rhee and Anna Serur

35 Chronic Constipation 271
Paula I. Denoya and Syed K. Abbas

Part IV Rectal

36 Retrorectal Tumors 281
Eric G. Weiss and Luanne Force

37 Rectal Cancer: Local Therapy 289
David M. Lisle and Dana R. Sands

38 Rectal Conditions: Rectal Cancer—Proctectomy 297
Aaron S. Rickles and Fergal J. Fleming

39 Rectal Conditions: Rectal Cancer—Adjuvant and Neoadjuvant Therapy 303
Terry Zwiep, Julie Ann Van Koughnett, and Patrick H. D. Colquhoun

40 Rectal Conditions: Stage IV Rectal Cancer 315
Russell C. Langan and Martin R. Weiser

41 Rectal Cancer: Watch and Wait 321
Angelita Habr-Gama, Guilherme Pagin São Julião, Bruna Borba Vailati, and Rodrigo Oliva Perez

42 Rectal Conditions: Rectal Cancer—Postoperative Surveillance 327
Daniel I. Chu and Gregory D. Kennedy

43 Recurrent Rectal Cancer 331
Ian White and Shmuel Avital

44 Locally Advanced Rectal Cancer. 341
Daniel W. Nelson and Anton J. Bilchik

Part V Colonic

45 Colonic: Diverticulitis 353
Matthew T. Brady and Jason F. Hall

46 Colonic Conditions: Large Bowel Obstruction 363
Sarah B. Stringfield and Bard C. Cosman

47 Colonic Conditions: Volvulus 367
Richard Garfinkle and Marylise Boutros

48 Colonic Stricture . . . 375
Estelle J. Williams and Erin O. Lange

49 Acute Colonic Pseudo-Obstruction (ACPO): Ogilvie's Syndrome . . . 381
Anathea C. Powell and David A. Etzioni

50 Colonic Conditions: Irritable Bowel Syndrome (IBS) . . . 387
Crystal P. Koerner and Patrick S. Sullivan

51 Colorectal Trauma . . . 393
Sean C. Glasgow and Fia Yi

52 Endometriosis . . . 399
Bidhan Das and Michael J. Snyder

53 Colonic Conditions: Ulcerative Colitis . . . 405
Megan C. Turner and John Migaly

54 Colonic Conditions: Indeterminate Colitis . . . 417
Jon D. Vogel and Mariana Berho

55 Colonic Conditions: Toxic Colitis . . . 423
Carmen Fong and Benjamin Abbadessa

56 Crohn's Colitis . . . 431
Meagan M. Costedio and Leonardo C. Duraes

57 Ischemic Colitis . . . 437
Alodia Gabre-Kidan and David J. Maron

58 Colonic Conditions: Infectious Colitis . . . 441
William C. Cirocco and Shandra R. Day

59 Colonic Conditions: Benign Colonic Neoplasia . . . 451
Taryn E. Hassinger and Charles M. Friel

60 Familial Adenomatous Polyposis . . . 459
Emily Steinhagen

61 Colonic Conditions: Lynch Syndrome . . . 469
Matthew F. Kalady

62 Malignant Colon Polyps . . . 479
Andrea M. Petrucci and Mariana Berho

63 Colonic Conditions: Adenomatous Polyps . . . 483
Steven A. Lee-Kong and P. Ravi Kiran

64 Colon Cancer Surgical Therapy . . . 489
Lameese Tabaja, Yasir Akmal, and Maher A. Abbas

65 Colonic Conditions: Locally Advanced Colon Cancer . . . 503
Najjia N. Mahmoud

66 Recurrent Colon Cancer 511
David Liska and Luca Stocchi

67 Appendiceal Neoplasms 517
Alison R. Althans and Scott R. Steele

Part VI Small Bowel

68 Small Bowel Conditions: Small Bowel Crohn's Disease 529
Janet T. Lee and Wolfgang B. Gaertner

69 Small Bowel Desmoid Disease 539
Jean H. Ashburn

70 Mesenteric Ischemia 545
Alexis R. Harvey, Alison R. Althans, and Anuradha R. Bhama

71 Small Bowel Conditions: Small Bowel Obstruction. 551
James P. Taylor and Jonathan E. Efron

72 Small Bowel Conditions: Radiation-Induced Small Bowel Disease (RISBD): Radiation Enteritis 557
Guy R. Orangio

73 Enterocutaneous and Enteroatmospheric Fistula 573
Jason R. Bingham and Eric K. Johnson

74 Small Bowel Polyps 583
Cristina B. Geltzeiler and Matthew G. Mutch

75 Small Bowel Lymphoma. 591
Mahmoud Abu Gazala and Alon J. Pikarsky

76 Small Bowel Conditions: Carcinoid 595
Ahmed AL-Khamis and Patricia Sylla

Part VII Stomas

77 Stomal Prolapse. 607
David J. Hiller and Juan J. Nogueras

78 Stomas: Parastomal Hernias 611
David E. Beck

79 Stoma Retraction and Stenosis 623
James Tankel and Yair Edden

80 Stomal Varices 629
Sean J. Langenfeld

81 Stomas: Peristomal Skin Complication. 635
Alex J. Ky and Nir Horesh

Part VIII Complications

82 Complications: Ureteral Injury 643
Fiona M. Gaunay, Titilayo O. Adegboyega, Geoffrey S. Gaunay, and David E. Rivadeneira

83 Splenic Injury Complicating Colorectal Surgery 651
Shlomo Yellinek and Petachia Reissman

84 Colonoscopic Complications: Colonic Perforations. 659
Andrew T. Strong and Jeffrey L. Ponsky

85 Complications: Early Anastomotic Complications—Leak, Abscess, and Bleeding. 667
Vahagn C. Nikolian and Scott E. Regenbogen

86 Late Anastomotic Complications (Stricture and Sinus) 675
David B. Stewart Sr.

87 Post-polypectomy Bleeding 681
Avery S. Walker and David A. Margolin

88 Post-polypectomy Complications. 685
Sandra Rodriguez and Tolga Erim

89 Presacral Bleeding. 695
Avery S. Walker and David A. Margolin

90 Complications: Short Gut Syndrome 699
Ramzi M. Helewa and Robin P. Boushey

91 Complications: Surgical Site Infections 711
Elizabeth Arcila and Kyle G. Cologne

92 Ileal J Pouch Complications. 719
Pasha J. Nisar and Ravi P. Kiran

93 Complications: Pouchitis 729
Bo Shen

94 Complications: Reoperative Pelvic Surgery. 735
Monika A. Krezalek and Neil H. Hyman

Index. 741

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Part I

Evaluation and Perioperative

Anorectal Examination

1

Nilam D. Patel, Scott R. Steele,
and Emily Steinhagen

Refer to Algorithm in Fig. 1.1

A. Chief Complaint

Eliciting a thorough history of the chief complaint is a critical first step in evaluating an anorectal complaint. Because of the sensitive nature of the complaint, patients may be reluctant or embarrassed to volunteer details, thus specific questions are helpful. Often, a careful history will enable the clinician to diagnose the patient and the physical exam is confirmatory. At a minimum, it will make it possible to generate a focused differential diagnosis. The quality, location, and duration of the chief complaint should be elicited. The patient should be asked about palliating and provoking factors such as eating and bowel movements. Common chief complaints include, but are not limited to: bleeding, anorectal pain, constipation, diarrhea, fecal incontinence, a palpable lesion, and itching. A list of common anorectal Complaints and pathologies is found in Table 1.1. It is important to note the quantity of bleeding, timing of blood loss, and characterization as melena or hematochezia as these details suggest different pathologies. Other general inquires that can be helpful are whether the patient feels pain or pressure with bowel movements, if there has been a change in the caliber, quality, or frequency of the stool, tenesmus, incomplete evacuation, urgency, and characterization of rectal discharge (bloody, mucoid, liquid, fecal) if present. It is worthwhile to ask what the patients have already done to try to treat the problem. Finally, it should be noted if the patient has experienced associated systemic changes such as weight loss, fatigue, nausea, or abdominal pain. Further targeted questioning will be dependent on the suspected pathology.

B. History

Understanding the patient's past medical history, family history, and various other details regarding their health and daily activities is the next step for proper evaluation of anorectal complaints. It is important to inquire whether there is a personal or family history of inflammatory bowel disease or colorectal malignancy. Medications should be reviewed as some may cause or exacerbate anorectal symptoms. Specific classes of medications to

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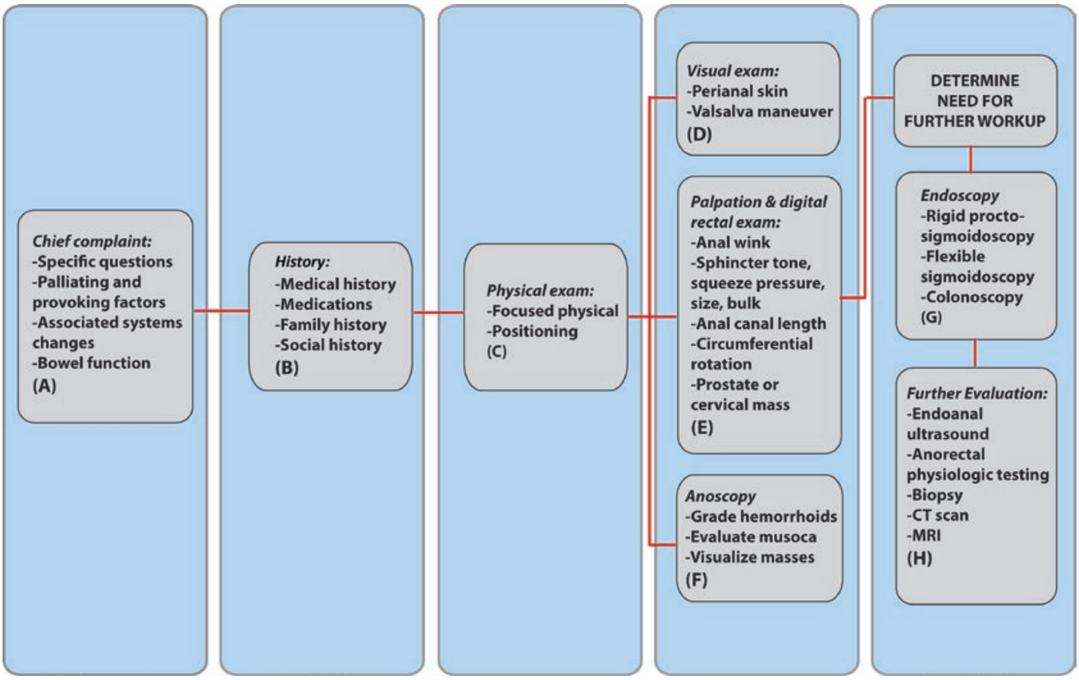

Fig. 1.1 Algorithm for anorectal examination

Table 1.1 Common anorectal compliant and pathologies

Complaints	Pathologies
Bleeding	Hemorrhoids
Rectal discharge	Anal fissures
Itching	Anal fistula
Anorectal pain	Stricture
Constipation	Abscess
Diarrhea	Rectal prolapse
Fecal incontinence	Pelvic floor dysfunction
Palpable lesions	Skin tags
Prolapse	Pilonidal disease
Pain or pressure with bowel movements	Infection
Incomplete evacuation of stool	Condyloma
Tenesmus	Pruritus ani
	Inflammatory bowel disease
	Hypertrophied anal papillae
	Malignancy

note include antiplatelet agents, anticoagulants, and anticholinergics. Previous colorectal surgeries, anorectal procedures, and endoscopes should be discussed. Some gastrointestinal procedures including cholecystectomy and gastric bypass are relevant because these can be involved in common gastrointestinal and anorectal symptoms. Social, sexual, and dietary histories need to be elicited including smoking history, fiber and fluid intake, and sexual history of anal-receptive intercourse. A history of urinary issues may also be potentially relevant. Finally, a comprehensive family history should be taken including history of hemorrhoids, polyps, colorectal cancers, other cancers, and inflammatory bowel disease. A positive family history of certain malignancies may put the patient at a higher risk of developing cancer and changes the screening guidelines for colonoscopy.

C. Physical Exam

The physical exam may make the patient feel vulnerable and embarrassed, so it is important to establish a relaxed and professional environment for the exam. An assistant should be present during the exam, the patient should be draped properly, and efforts should be made to communicate with

the patient throughout the exam. An overly apprehensive or anxious patient may have an anal or gluteal spasm that can hinder a proper exam. A focused physical exam with attention to the abdomen and inguinal regions is recommended prior to the anorectal exam. There are three positions that allow for adequate exposure for anorectal exam. The first and most optimal is the prone jackknife position. This position allows for full visualization of the entire anus and the perianal, perineal, and sacral regions. The Sims' position, also referred to as the left lateral decubitus position, places the patient on the left side with the buttocks slightly off the edge of the table with the right knee and hip in flexion to form a 90° angle with the trunk. This position is useful when a proctoscopic table is not available or the patient is elderly or debilitated. However, it does not allow for optimal visualization of the perineal region. Lastly, lithotomy is not ideal for most examinations, but may be used if necessary, or if indicated by complaints such as rectovaginal fistula.

D. Visual Inspection

The anorectal exam should begin with visualization of the external aspects of the perianal region by gentle spreading of the buttocks. Careful examination of the skin evaluates for scars, skin tags, inflammation, pruritus, excoriations, condyloma, fecal soiling, blood or mucous discharge, hemorrhoids, rectal prolapse, fissures, external fistula openings, perineal body bulk, sphincter shape, and mass. If rectal, uterine, vaginal, or bladder prolapse are suspected, the Valsalva maneuver should be performed in which the patient is asked to bear down. If rectal prolapse is suspected but cannot be elicited on the exam table, the Valsalva maneuver may be performed in a squatting or sitting position over a toilet with utilization of handheld mirror for examination. Findings from visual exam should be documented avoiding clock-face descriptions as they differ based on patient position; instead, directional terms such as anterior/posterior or left/right should be utilized.

E. Palpation and Digital Rectal Exam

The next step of the anorectal evaluation is palpation of the perianal skin and a digital rectal exam using a gloved and well-lubricated index finger. To evaluate the function of the pudendal nerve, the anocutaneous reflex, "anal wink", can be elicited by gentle scratching of the perianal skin around the anal verge. Next, the lubricated index finger should be gently inserted into the rectum and the following should be assessed: resting sphincter tone and squeeze pressure, sphincter size and bulk, and anal canal length. A circumferential rotation of the finger is required to appreciate a global assessment for masses or sensitivity. To fully evaluate for abnormalities and masses, the prostate should be palpated in males and the cervix in females. If a mass is identified, the extent and location needs to be noted and it should be characterized as firm or soft, fixed or mobile, and rough, smooth, or ulcerated. If the patient cannot tolerate the exam due to pain or sensitivity, the exam may require the use of a topical anesthetic, be deferred, or potentially be performed under anesthesia.

F. Anoscopy

After the completion of the digital rectal exam, anoscopy should be completed to visually inspect the interior of the anal canal and rectum. A lubricated, lighted anoscope should be slowly advanced into the anus until it is fully inserted. Anoscopy can be used to grade hemorrhoids and determine whether they prolapse outside of the anal canal. Other conditions that can be evaluated via anoscopy are the presence of inflammation on the mucosa, fissures, hypertrophied anal papillae, mass, or internal fistula opening.

G. Endoscopy

Endoscopy is undertaken to obtain visualization of the rectum and distal sigmoid colon. This is typically done when there is no clear evidence from prior exams that point to an etiology of the anorectal complaint or to ensure that the complaint is related to an anorectal finding and not a more proximal lesion. Rigid proctosigmoidoscopy and flexible sig-

moidoscopy are the most common endoscopic procedures. With proper technique, patients should feel minimal discomfort with these procedures. Formal bowel prep is not required; the rectum and distal sigmoid can be cleaned with a single phosphate based enema prior to the procedure. Rigid proctosigmoidoscopy is useful for examining and obtaining a biopsy from the entire rectum and the distal sigmoid colon. The full length of the proctoscope is 25 cm and circumferential exam is undertaken upon slow withdrawal of the scope. It is the standard tool for measuring the distance of a rectal tumor from the dentate line or anal verge because of its increased accuracy over the flexible scope. Flexible sigmoidoscopy is used more often because of increased patient comfort, ease of the exam, and a three- to sixfold increase in yield of findings in the rectum and sigmoid colon compared to rigid proctoscopy. The average length of the flexible scope is 60 cm and indications for this procedure include bright red rectal bleeding, radiation and other types of proctitis, Crohn's colitis, neoplasia, post-operative evaluation of anastomoses, and suspected strictures. Despite the advantages of flexible sigmoidoscopy, this procedure does not substitute for colonoscopy. Colonoscopy is indicated as the endoscopic procedure of choice when the workup does not clearly identify the causative issue or when otherwise indicated based on age and family history.

H. Further Evaluation

Further diagnostic evaluation may be necessary depending on the nature of the complaint and the findings gathered from the preceding exams in this algorithm. Endoanal ultrasound (EUS) can be useful for gathering more details involving pathologies such as an abscess, fistula, or tumor as well as evaluating the pelvic floor structures and anal sphincter. For determining the pathology of ulcerations or masses observed throughout the exam, biopsy can be obtained via anoscopy or endoscopy. Anorectal physiologic testing including manometry, measurement of rectal volume sensation, rectoanal inhibitory reflex, and balloon expulsion can be used to investigate underlying etiology of pelvic floor dysfunction. MRI is recommended for the staging of rectal tumors and a CT scan is recommended assessment of metastatic disease.

Conclusion

A comprehensive anorectal evaluation is an important process in the care of a patient with an anorectal complaint. This algorithm guides clinicians in a stepwise process through the history and physical examination. Equipped with the information elicited through this evaluation, the clinician can move forward to develop an assessment and treatment plan for the patient's anorectal complaint.

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2 Anorectal and Colonic Evaluation

Jason S. Mizell and Kaitlin Domek

Refer to Algorithm in Fig. 2.1

A. In addition to the overall history regarding general state of health, a detailed history focusing on the timing (i.e., chronicity or events surrounding the onset of symptoms) allows formation of a differential diagnosis based on questions related to rectal bleeding, pain, changes in bowel habits, systemic symptoms, and significant past medical history.
B. An abdominal examination should be performed, noting distension, tenderness, palpable masses, hernias, hepatosplenomegaly, and previous surgical scars.
C. Anal inspection requires adequate lighting and positioning of the patient in the left lateral or prone position. Inspect for abnormal masses or tissue, color and condition of the perianal skin, any scars, and abnormal shape of the opening of the anus. A baseline anal exam at rest and during coughing should be conducted. Any soiling of either the perianal skin or the undergarments should be noted. Often, excoriations may be present that may indicate dermatitis/pruritus or a history of seepage. All skin tags and other irregularities should be described and ultimately all of the information gleaned from the inspection should be diagrammed in the medical record.
D. Digital examination includes a prostate examination in males and examination of the posterior vaginal wall in females. The examination includes a full 360° sweep of the anal canal and the lower rectum. Care should be taken to feel the entire anal canal versus quick entry and exit, as subtle lesions and even fissures may be detected on digital examination. Resting tone and muscle function on attempted defecation should be noted, as should puborectalis tone and motion. The patient should be asked to bear down to descend the rectum towards the anal opening, allowing for some mid-rectal abnormalities (lesions, intussuscepting rectal wall) to come into contact with the fingertip.
E. Anoscopy evaluates the anal canal: anoderm, dentate line, hemorrhoidal area, and the lower most rectal mucosa. A side-viewing instrument is optimal, as any enlarged hemorrhoids can prolapse into sight. Conversely, end-viewing instruments, such as a retroflexed sigmoidoscope, reduce tissue away from the anal orifice. Each quadrant, including the three major hemorrhoidal sites as well as potential anterior and posterior fissure sites, should be evaluated. In addition to a written description of any findings, a dia-

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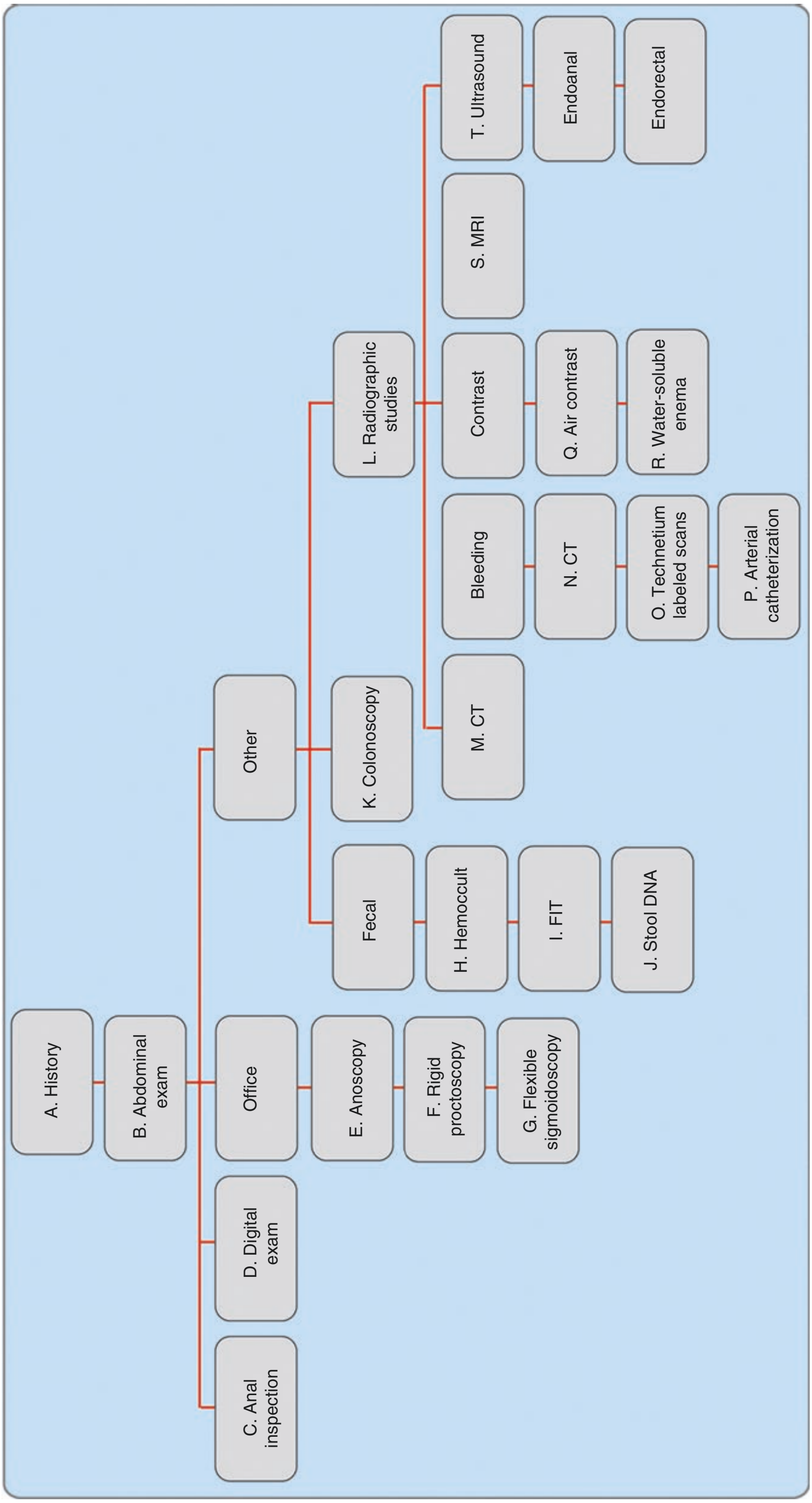

Fig. 2.1 Algorithm for anorectal and colonic evaluation. *FIT* Fecal immunochemical test

grammatic representation is helpful both to other physicians and for subsequent re-evaluations. In particular, non-operative hemorrhoid therapy can be quantifiably monitored.

F. Rigid proctoscopy allows visualization of the rectum and distal sigmoid. Its best use is for measurement of the distance from the anal verge or dentate line of rectal tumors and evaluation of proctitis.

G. Flexible sigmoidoscopy allows inspection of an additional 40–60 cm of proximal sigmoid and descending colon. It requires more special training and equipment than does rigid examination. However, the ability to use video is an added advantage. In addition to a written description of any findings, a diagrammatic representation and/or photos may be helpful to other physicians and for subsequent re-evaluation. Specifically, the response to topical therapy for proctitis can be quantifiably monitored. Other uses include pouchoscopy, rectal bleeding, or pain, and this procedure may be performed in the clinic or endoscopic center.

H. Hemoccult testing may be used to document heme-positive stool or in conjunction with proctosigmoidoscopy as a screening tool for colorectal neoplasia. More specifically for FOBT, it is important to avoid certain food products and medications during the testing period as described in the specific instructions accompanying the cards, as a false-positive or false-negative may result. The sensitivity of a single gFOBT in detecting cancer is in the range of 30–40%.

I. Fecal immunochemical test (FIT) also detects occult blood in the stool. It has the advantage of detecting occult blood limited to the lower gastrointestinal tract. Its sensitivity in detecting colorectal cancer has been reported to be approximately 73.8%.

J. Multi-target stool DNA tests detect mutations and epigenetic changes in stool DNA that may indicate the presence of colorectal cancer. The sensitivity of such tests for the detection of colorectal cancer is 92.3% and the specificity is 86.6%. The multi-target DNA test is superior to FIT in detecting cancer and advanced precancerous lesions.

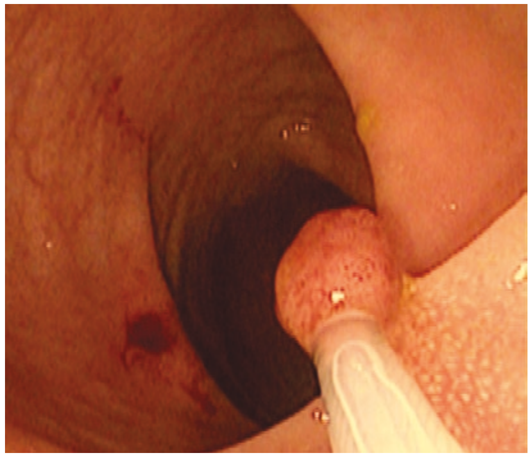

Fig. 2.2 Colonoscopy

K. Colonoscopy allows for the complete visualization of the colon (Fig. 2.2). It is useful for patients who have lesions noted by radiographic studies or by proctosigmoidoscopy; a personal or family history of neoplasia, unexplained anemia, lower GI/rectal bleeding, or hemoccult positive stools. Additionally, colonoscopy is predominately used in asymptomatic patients for screening for colorectal malignancy, as well as in patients with a history of inflammatory bowel disease for disease surveillance and colorectal cancer screening.

L. Radiographic studies are indicated in the evaluation of acute GI bleeding, anastomotic leaks, constipation, and incontinence. They are also indicated when formal colonoscopy cannot be completed and when staging rectal cancers.

M. Computed tomography colonography uses CT technology to reconstruct images of the bowel wall and mucosa. Sedation is not necessary for this imaging modality, and it avoids the risk of colonic perforation. It is important to realize that bowel preparation is still required. CT colonography is more sensitive in the detection of colorectal cancer in symptomatic patients than barium enema. If

the CT colonography is positive, then this result must be confirmed with colonoscopy.

N. In patients with acute GI bleeding, CT angiography can help localize the bleeding. It can detect bleeding at a rate of less than 0.5 mL/min. Limitations include the lack of therapeutic benefit and exposure to radiation and contrast media.

O. Technetium-labeled scans are useful only in the actively bleeding patient for localization or (to a lesser degree) lateralization of the bleeding. The study has no therapeutic benefit, but is noninvasive and allows detection of 0.1–0.5 mL/min of blood loss. It also serves to help focus angiography.

P. Selective visualization via mesenteric vessels is an invasive procedure that requires arterial catheterization. It allows detection of ≥0.5 mL/min of blood loss. The technique very accurately localizes bleeding and may also be therapeutic with either vasopressin infusion or embolization.

Q. Air-contrast study is superior to the single-column study. It is indicated for the detection of colon cancer and diverticula in patients for whom colonoscopy cannot be completed.

R. Water-soluble enemas are used when colonic obstruction, pseudo-obstruction, or an acute inflammatory process is suspected (though are typically avoided in conditions such as toxic megacolon). It is also used to evaluate for an anastomotic leak. However, water-soluble agents provide less detail than barium (Fig. 2.3). Contrast enemas are often used to evaluate anastomoses in cases of low anterior resection with proximal diversion prior to ileostomy takedown.

S. Magnetic resonance has three main roles: evaluation and staging of rectal neoplasia, evaluation of pelvic anatomy, and assessment of functional disorders (Fig. 2.4). For rectal neoplasms, particularly adenocarcinoma, MRI is used preoperatively to assess T and N stage and postoperatively to assess response to treatment. Additionally, MRI provides high quality imaging for evaluation of anatomy of the rectum, bony pelvis, pelvic soft tissue and musculature, and urinary and reproductive organs. The resolution is superior to CT in this regard. Lastly, MRI can be used to evaluate for functional and anatomic disorders such as pelvic organ prolapse, cystoceles, urethroceles, rectoceles, enteroceles, abnormal pelvic floor relaxation, rectal prolapse, and intra-rectal intussusception. It is performed by placing contrast gel into the

Fig. 2.3 Water-soluble enema

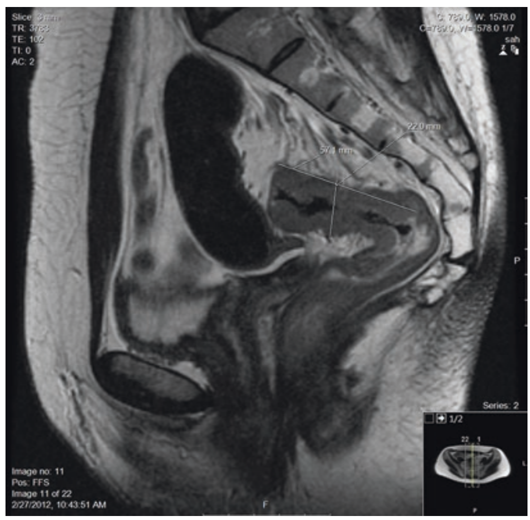

Fig. 2.4 Magnetic resonance imaging (MRI)

rectum and obtaining magnetic resonance images at rest and during defecation. The advantages of MR defecography include the avoidance of radiation and the possibility to obtain high-resolution images of the functional dynamics of the pelvic floor musculature and pelvic organs.

T. Endoanal ultrasound can evaluate anal sphincter defects in patients with incontinence. Its role in staging of malignancy has been supplanted by rectal cancer protocol MRI.

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Physiologic Testing

3

Kirsten Bass Wilkins and Joseph R. Notaro

Refer to Algorithm in Fig. 3.1

A. Fecal incontinence refers to the involuntary loss of feces or flatus. In population studies, the reported overall prevalence of fecal incontinence approaches nearly 20% of women, while the prevalence in males is not as well defined. This percentage increases dramatically in nursing home residents and fecal incontinence is a frequent factor in nursing home placement. The etiologies of fecal incontinence are numerous and therefore an accurate history and physical examination are an important first step in assessing the possible causes.

B. A careful history is required focusing not only on potential medical conditions predisposing to fecal incontinence, but also obstetric and surgical history. The patient is questioned regarding medical conditions leading to diarrhea or frequent stools such as irritable bowel syndrome, inflammatory bowel disease, celiac disease, hyperthyroidism, lactose intolerance, radiation therapy, etc. Patients are asked about constipation as this may cause overflow fecal incontinence. Medical conditions causing neuropathy such as diabetes and multiple sclerosis are occasionally an etiology of incontinence. Certain medications may be associated with diarrhea, specifically diabetes medications, and create problems with continence that formed stools may not. Similarly, sugar-free foods containing sorbitol and excessive caffeine intake can also cause loose stools resulting in loss of control. Obtaining an obstetric history is imperative as vaginal delivery is the leading cause of fecal incontinence in women who have had children. Delivery details such as prolonged labor, episiotomy, lacerations, forceps/vacuum delivery, and large birth weights are elicited as these are associated with a higher rate of significant sphincter defects. Surgical history such as perirectal abscess drainage, anal fistula surgery, hemorrhoidectomy, previous sphincteroplasty, partial lateral internal sphincterotomy, and rectal cancer surgery, may provide clues as to the etiology of incontinence. In addition, patients should be asked about anal intercourse and anal trauma. Patients are questioned about swelling in the anal area that may be associated with prolapsed internal hemorrhoids or rectal prolapse. The patient is asked about the consistency of stool that is leaked, the frequency of leakage, whether or not they need to wear a pad because of the leakage, and the impact of incontinence on lifestyle modification. These answers are used to score the severity of the fecal incontinence. Several

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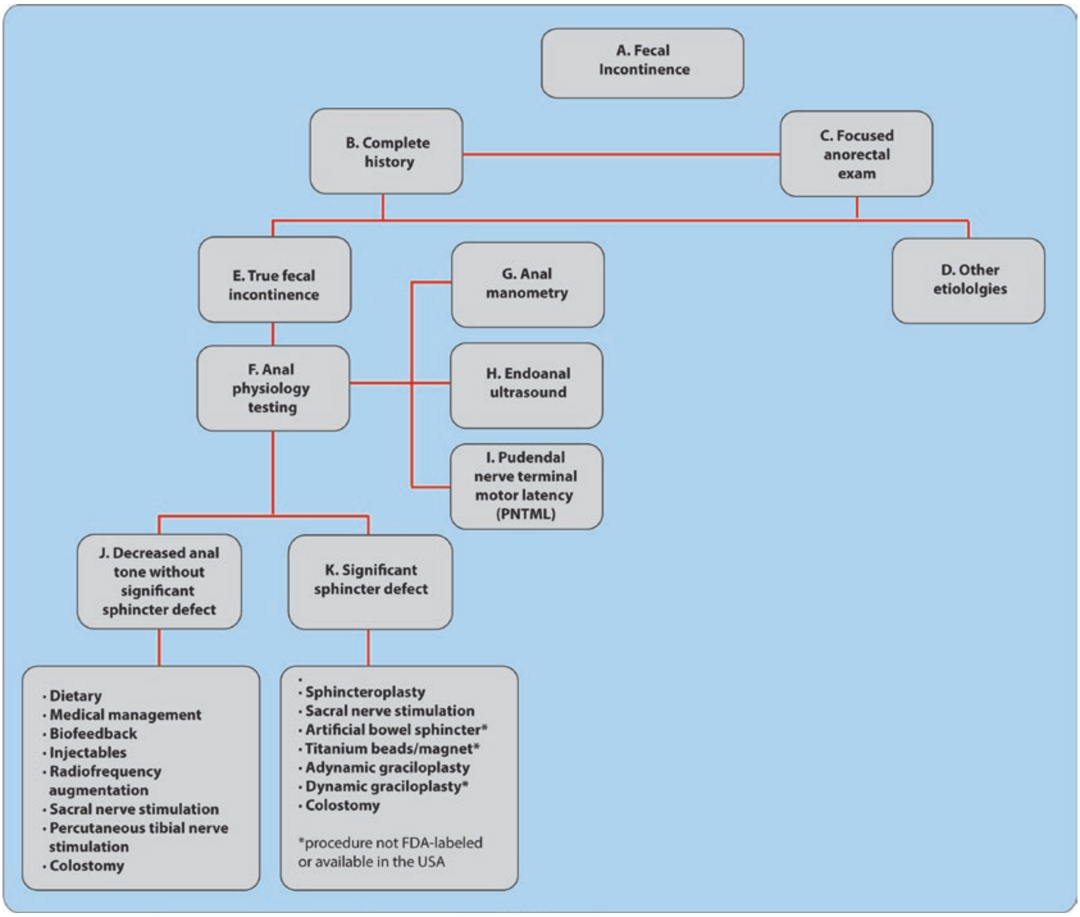

Fig. 3.1 Algorithm for the initial evaluation and physiologic testing for fecal incontinence

scoring systems are available, but the most commonly utilized scoring system is the Cleveland Clinic Florida Fecal Incontinence Score (CCF-FIS).

C. Physical examination of the anorectal area may be undertaken in the left lateral or prone jackknife position. Visual inspection is crucial and focuses on anal tone and anal pathology that may be associated with seepage that the patient may perceive as incontinence such as anal fistula, prolapsed internal hemorrhoids, rectal prolapse, and condyloma. A search for scars in the anal area and any distortion of the anal canal may correlate with a history of previous anorectal surgery or episiotomy. In women, the perineal body is assessed looking for any obvious thinning that would be associated with a sphincter defect. The perianal skin is grasped and touched to assess overall sensation. Digital examination reveals any masses or irregularities such as a rectocele and allows a subjective assessment of anal sphincter strength. In addition, the patient is asked to squeeze the examining finger. If rectal prolapse is suspected, but is not seen at rest, the patient is asked to sit on the commode and Valsalva to see if the prolapse can be produced. It is important to note that upwards of 1/3rd of patients may have concomitant pelvic floor

defects. Anoscopy allows the assessment of hemorrhoids and distal lesions. Rigid proctoscopy or flexible sigmoidoscopy should be done to evaluate signs of proctosigmoiditis that could be associated with inflammatory bowel disease, or sexually transmitted disease. If the patient is of appropriate age or symptoms warrant the exam, a full colonoscopy should be scheduled.

D. The complete history and physical examination should reveal whether or not the patient has fecal incontinence from an anal sphincter related cause which warrants further evaluation in the anal physiology laboratory or if the patient has a condition that requires medical or surgical therapy such as inflammatory bowel disease, radiation proctitis, anal fistula, hemorrhoids, or rectal prolapse.

E. Patients with true fecal/flatal incontinence may then be evaluated in the anal physiology laboratory.

F. Anal manometry, endoanal ultrasound, and pudendal nerve testing are easily performed in the physiology laboratory. Each of these modalities will be discussed below individually (Fig. 3.2).

G. Anal manometry is used to examine the resting and squeeze pressures of the anal sphincter complex, the length of the high-pressure zone, rectal sensation, and rectal compliance. Two types of conventional manometry probes are available including water-perfused and solid-state catheters. A deflated balloon is present at the tip of the catheter. Manometry is usually performed in the left lateral decubitus position with the knees flexed. The catheter is inserted to 5–6 cm into the rectum and then rest and squeeze pressures are obtained at each 1 cm mark as the catheter is pulled distally. The patient is asked to hold the squeeze as long as possible to evaluate for fatigue. In the anal canal, normal resting pressures are above 40 mmHg. Squeeze pressures should be at least 100 mmHg. The high-pressure zone is typically 2–3 cm in length. Men tend to have higher resting and squeeze pressures and longer high pressure zones as compared to women. After resting and squeeze pressures have been recorded, balloon inflation is performed to assess sensation and compliance. The balloon is inflated with the catheter in the anal canal. Air or water is used to inflate the balloon. First sensation by the patient is recorded and is normally approximately 20 ml. First urge to defecate is usually between 80 to 120 ml, and maximum tolerable volume usually ranges from 200 to 250 ml. Compliance may be measured by dividing balloon volume by balloon pressure and a normal range is approximately 10 ml/mmHg. The rectoanal inhibitory reflex is also assessed with balloon inflation but is more important in the evaluation of constipation and is discussed below. Resting pressure is predominantly a reflection of the strength of the internal anal sphincter while the squeeze pressure reflects the strength of the external anal sphincter. Rectal sensation may be low in conditions such as diabetic neuropathy and may be increased in conditions such as inflammatory bowel disease. First urge to defecate may be high in those with a rectocele or megarectum and may be low in those with irritable bowel syndrome. Maximum tolerable volume may be low and compliance poor in those with diseases such as scleroderma. High resolution anal manometry is available in certain settings and utilizes a system with multiple sensors on a single probe and can determine the pressures throughout the anal canal without repositioning the catheter. This technique allows for three-dimensional reconstruction of the anal canal. While anal manometry is useful, manometric findings do not always correlate with the severity of fecal incontinence or the response to therapeutic interventions.

H. Endoanal ultrasound can be very useful in evaluating patients with suspected sphincter defect including patients with a history of vaginal delivery, previous anorectal surgery, anal intercourse, or anal trauma. The patient is typically positioned in the left lateral decubitus position with the knees flexed. The

Gastrointestinal/ Anorectal Physiology Testing

Fecal Incontinence

Anal Manometry

- Rest/Squeeze Pressures
- Cough
- Rectal Sensation
  - First Sensation
  - First Urge
  - Maximum Tolerable Volume
- Compliance

Endoanal Ultrasound (or Anal MRI)

- Rule out defect
- If defect present, quantify the degree of defect

Pudendal Nerve Terminal Motor Latency (controversial)

Constipation

Anal Manometry

- Recto-anal Inhibitory Reflex (RAIR)
- Balloon Expulsion (Outlet Obstruction)
- Resting Pressure (Hypertonia)
- Compliance (Megarectum)

EMG

- Non-relaxing Puborectalis
- Paradoxical Puborectalis

Metabolic Evaluation

- Thyroid Function Tests
- PTH intact, Ca^{++}, Mg^{++}, $Phos^{--}$

Colonic Transit Study

- Radiopaque Markers
- Nuclear Scintigraphy
- Wireless Motility Capsule
- High Resolution Colonic Manometry
- Colonic Barostat

Gastric Emptying Study

Cinedefecography, MRI Dynamic Pelvic Floor Defegram, Transperineal Dynamic Ultrasound

Fig. 3.2 Gastrointestinal/anorectal physiology testing that is indicated for the evaluation of fecal incontinence versus constipation

well-lubricated ultrasound cap is inserted into the anal canal. Two and three dimensional ultrasound scanners are available with a 7 or 10 MHz rotating endoprobe that allows for a 360° evaluation of the anal sphincter complex. Older machines require manual withdrawal to assess the proximal and distal extent of the sphincter complex, while newer machines, have a crystal that can be moved proximally and distally without moving the probe. The anal canal is divided into proximal, middle, and distal aspects that are easily identified on ultrasound. The proximal anal canal is defined by the presence of the puborectalis sling. The middle anal canal is identified by the presence of the external and internal anal sphincter complex. The distal anal canal is distal to the internal anal sphincter and only the external anal sphincter is visualized. The internal anal sphincter is easily identifiable due to its hypoechoic nature (black on ultrasound imaging). The puborectalis and external anal sphincter are hyperechoic (white on ultrasound imaging). Ultrasound is used to assess for defects in internal anal sphincter, external anal sphincter, and puborectalis muscle. The location as well as the degree of the defect or defects is recorded. The perineal body can also be imaged and measurements obtained. Perineal body measurements less than 1 cm are typically associated with sphincter injury. The presence of a sphincter injury alone may not predict the severity of incontinence. For

example, there may be occult sphincter injury in nearly 35% of women after vaginal delivery. However, the degree of sphincter injury in patients with fecal incontinence may be very useful in guiding therapy. Anal magnetic resonance imaging may also be used to visualize the anal sphincter complex, however the expense and greater variability in interpretation make this technique less desirable.

I. Pudendal nerve terminal motor latency may be obtained, but is of limited usefulness in the diagnosis and management of fecal incontinence. The pudendal nerves innervate the external anal sphincter. Pudendal nerve terminal motor latency (PNTML) is defined as the time it takes from stimulation of the nerve until sphincter contraction. Normal values are in the range of 2.0 ± 0.2 ms. The exam is undertaken with the patient in the left lateral decubitus position with the knees flexed as close to the chest as possible. The examining index finger is covered with a St. Mark's electrode and rectal exam is performed. The index finger is used to hook the levator muscle on the left and right sides, respectively, at the level of the ischiorectal spines. The electrode is used to deliver the stimulus at which time the levator will contract. The response is recorded usually three times and the process is repeated on the other side. The latency can be prolonged due to neuropathy of various etiologies including diabetes and stretch injury from pregnancy or delivery.

J. Physiology testing will separate those patients with sphincter defects who may be amenable to surgical intervention versus individuals without significant sphincter defects. In all patients, the first intervention should be non-operative consisting of dietary manipulation and medical management. Patients should keep a food diary and avoid foods that cause loose stool such as lactose, caffeine, or sorbitol. They should be advised to be on a fiber rich diet with fiber supplementation to bulk the stools. Medications contributing to diarrhea should be switched to alternatives when possible. Cholestyramine is useful as a bile-binding agents in patients with post-cholecystectomy diarrhea. Loperamide and lomotil decrease the amount of diarrhea, but also increase tone in the internal anal sphincter. Local perineal skin care with barrier creams is helpful in alleviating excoriation. Tap water cleansing enemas may be useful to reduce the number of episodes of incontinence in those with overflow due to constipation or rectocele. Biofeedback should also be considered as an initial therapy in all patients assuming they have some ability to contract the sphincter complex. Biofeedback aims at not only improving sphincter strength but also to increase rectal sensation. Several techniques are available to augment the sphincter including injectables and radiofrequency ablation. Injectable agents such as hyaluronic acid dextranomer gel (to date, the only injectable agent approved by the FDA) may be injected submucosally in the office setting in those with mild fecal/flatal incontinence. Radiofrequency tissue remodeling (i.e. SECCA) utilizes radiofrequency energy delivery to the internal anal sphincter and results in collagen contraction and subsequent remodeling and tightening of connective tissue. While controversial, there is some data to suggest this process results in improved control in select patients. Sacral nerve stimulation is a good alternative in those patients without a definable sphincter defect who have not improved with dietary/medical manipulation and biofeedback, though is increasingly used as a first-line agent as well as those failures with biofeedback and non-operative therapy. The artificial bowel sphincter, stimulated graciloplasty, and percutaneous tibial nerve stimulation are not FDA approved at present. The magnetic anal sphincter and the anal sling are two newer therapeutic possibilities. Colostomy may be offered to patients and may greatly increase the quality of life.

K. In patients with sphincter defects multiple surgical options are available. As mentioned above, dietary measures and biofeedback should be utilized in all patients as an initial approach. In patients with well-defined ante-

rior sphincter defects from obstetric injury, sphincteroplasty is an option. Patients need to be informed that while good results are usual in the short-term, after 5 years, a significant proportion of patients are back to their baseline function. Repeat sphincteroplasty after a failed repair is typically not recommended unless other options are not feasible. Because of this observed deterioration with time, sacral nerve stimulation has become a first-line surgical alternative in those with a sphincter defect <180°. Colostomy is again an alternative for those without improvement following other interventions or in those who do not want to pursue other options.

Refer to Algorithm in Fig. 3.3

A. Normal bowel habit can range from three formed stools per day to one stool every 3 days. Definitions of constipation vary but usually include infrequent hard stools that require significant straining to pass. The Rome IV criteria define constipation in a patient with 2 or more of the following: less than three bowel movements a week, straining with more than 25% of bowel movements, sensation of incomplete evacuation or blockage more than 25% of bowel movements, manual maneuvers to facilitate more than 25% of bowel movements, and lumpy or hard stools in more than 25% of bowel movements. Also, loose stools are rarely present without laxatives and the patient must not meet criteria for IBS. Chronic constipation afflicts roughly 15% (range: 2–30%) of the U.S. population. In 2006, the number of constipation-related medical visits was nearly $6 million USD. Constipation—related health costs are nearly $7 billion a year in the U.S., of which $725,000 USD per year is spent on laxatives.

It is crucial to remember that constipation is a symptom with many causes. It is not an independent disease entity. Effective treatment can only be initiated after determining the specific cause. The etiology of constipation can be multifactorial thus posing a diagnostic and therapeutic challenge.

B. and C. After establishing that the patient meets criteria for constipation by determining the frequency and consistency of the stool, a careful history is obtained. The first step is to perform a dietary review of fiber/roughage/water intake including a thorough medication review to eliminate antidepressants, anticholinergics, opiates, antacids (aluminum/calcium), calcium channel blockers, sympathomimetics, psychotropic drugs and cholestyramine, as the etiology of constipation. The presence or absence of an urge to defecate can be an invaluable clue to the underlying process. The patient is asked if they frequently delay the call to stool. The patient is queried about the use of enemas in the past and the response to such treatment. No response to enemas may indicate colonic inertia whereas a normal response to an enema may indicate rectal outlet obstruction. Coexisting medical conditions such as Parkinson’s, multiple sclerosis, diabetic autonomic neuropathy, spinal cord lesions, cerebral vascular accidents (CVA)/strokes, scleroderma, and amyloidosis can cause debilitating constipation. Hypothyroidism and hyperparathyroidism are two common endocrine abnormalities that cause constipation. Therefore a metabolic workup including thyroid function tests and parathyroid hormone levels, calcium, magnesium, and phosphorus values, should establish or refute the diagnosis indicated in this scenario.

A focused anorectal exam may provide important clues. Rectal exam can assess for impaction, rectocele, rectal prolapse, and baseline subjective function of the pelvic floor (asking the patient to squeeze and push on the examining finger). Anoscopy and rigid sigmoidoscopy will exclude obstructing distal masses and solitary rectal ulcer syndrome. A physical exam can also exclude other causes of irregular bowel function as caused by benign or malignant conditions. Abdominal pain, weight loss, and anemia raise suspicion of a mechanical obstruction and should generally prompt colonoscopy and X-ray/CT scan.

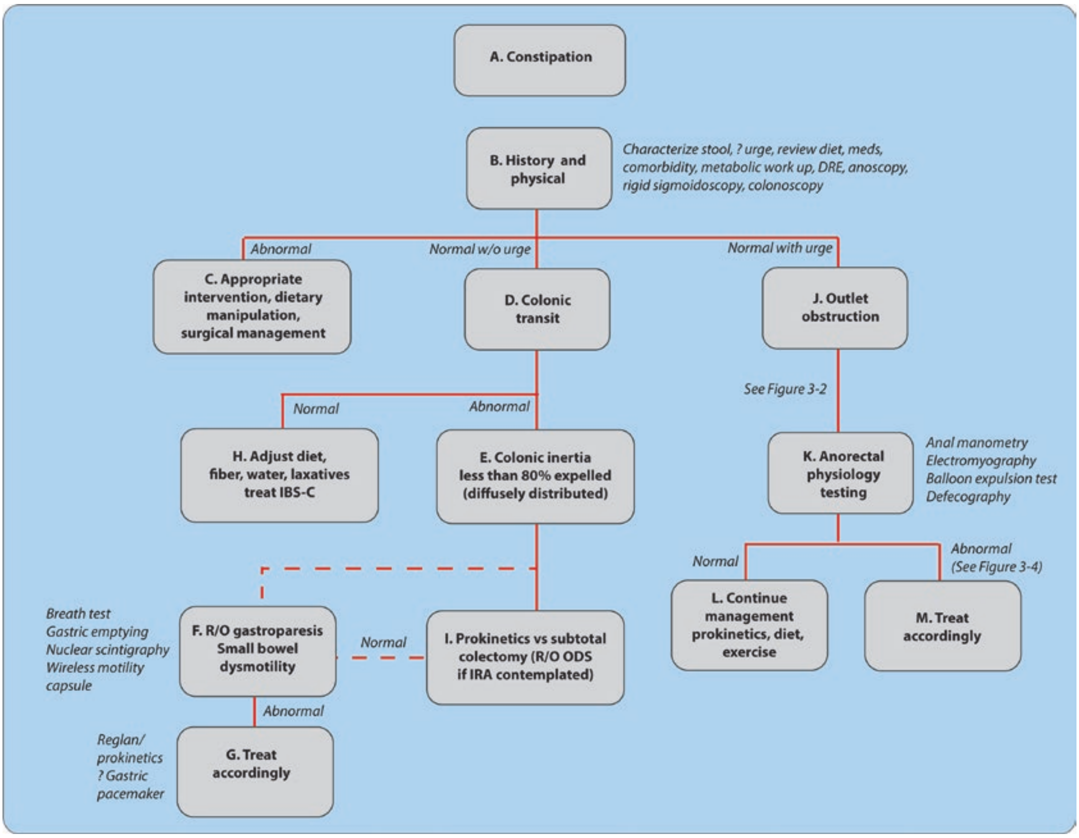

Fig. 3.3 Algorithm for the initial evaluation and physiologic testing for constipation

D.–H. When constipation is present without any urge to defecate with poor response to enemas, colonic inertia is suspected. Transit studies are used to provide a measurement of the colonic motor function. Radiographic markers studies including the Sitz marker test, is simple, noninvasive and relatively inexpensive. The two most common protocols involve the ingestion of a single gelatinous capsule containing 24 radiopaque rings. One option is to have a single plain film X-ray on day 5. Alternatively, one may obtain a plain X-ray on days 1, 3, and 5 (possibly 7) if there are still retained markers seen.

The latter method also gives indirect information regarding gastric emptying and small-bowel motility as well. Additionally, if the majority of markers accumulate in the rectosigmoid by day 3, obstructed defecation is suggested. A disadvantage however is multiple visits to the X-ray department and increased ionizing radiation exposure. Regardless of method, the location and number of markers is recorded. Elimination of greater than 80% of markers is a normal study. If less than 80% of the markers are eliminated and diffusely located throughout the colon, colonic inertia is suspected.

Scintigraphy, following the ingestion of a radiolabeled meal or charcoal, is performed using a gamma camera imager. This represents a time efficient and accurate means of measuring gastric, small bowel, and colonic transit. It is expensive, and radiation exposure along with limited expertise, pose significant disadvantages. Wireless motility capsule utilizes pH, pressure, and temperature to measure motility. After orally ingesting the capsule, information is transmitted to a portable data receiver worn by the patient. There is nearly a 90%

correlation with radio-opaque marker tests. It is easy to perform, lacks radiation exposure, and provides information on whole gut transit. It is expensive due to a non-reusable capsule. Newer techniques such as high-resolution colonic manometry, and colonic barostat, have been used to directly characterize colonic contraction patterns and categorize colonic dysmotility. These tend to be available only in specialized digestive disease centers, are expensive and technically very challenging.

Even after colonic inertia is evident on colonic transit study, certain patients require additional testing including the hydrogen breath test, gastric emptying study/nuclear scintigraphy, or wireless motility capsule to eliminate dysmotility proximal to the colon. Obviously performing a subtotal colectomy on these patients will not necessarily improve their symptoms. They instead would benefit from prokinetic and intestinal pacemaker in select cases. In those patients with isolated colonic inertia, a trial of colonic prokinetic agents is warranted, after maximizing fiber and water. Osmotic agents such as lubiprostone and linaclotide, stimulate intestinal fluid secretion by acting on the intestinal chloride channel and guanylate cyclase receptor, respectively. After initial success, then withdrawal from U.S. market, tegaserod, is again available (since 2014) via an emergency treatment investigational new drug protocol through the FDA. Newer agents, such as renzapride, a mixed 5-HT4 receptor agonist and 5-HT3 receptor antagonist, holds promise. If the colonic transit studies are normal and inertia is excluded, continue with fiber, water, laxatives, and treatment for IBS-C.

I. Surgical options may be discussed in patients who are refractory to all dietary and medical management. After exclusion of distal outlet obstruction, subtotal colectomy with ileorectal anastomosis can be offered in select patients. Segmental resections are fraught with prohibitive recurrences and subsequent patient dissatisfaction.

J. The act of defecation is a multi-step process involving many components—ranging from rectal compliance and anal sampling to abdominal Valsalva and sphincter relaxation. The pelvic floor comprised of the levator ani muscles and the endopelvic fascia, plays a crucial role in defecation. Pelvic floor disorders and dysfunction can result in various organ prolapses and functional disturbances of the evacuation process; rectal outlet obstruction is one such pelvic floor dysfunction.

Rectal outlet obstruction, also referred to as obstructed defecation syndrome, is suspected when a constipated patient gets the urge to defecate, but evacuates only partially or not at all. Response to laxatives is a watery loose stool (+/− over flow incontinence) without relief of the rectal pressure. Using an enema can have a successful response but does vary among patients and their specific pathology. The causes of obstructive defecation syndrome are multiple and varied (Fig. 3.4).

Physical exam alone has significant limitations in establishing the diagnosis. It may only be helpful with an obvious abnormality such as procidentia or rectoceles. Otherwise the colorectal surgeon must rely on anorectal physiology laboratory testing and imaging to confirm both the diagnosis and the pathology involved.

K. Once clinical suspicion of rectal outlet obstruction is established, extensive investigation is warranted (Fig. 3.2). In order to establish effective medical or surgical treatment, specific anorectal pathology must be identified. The assessment of obstructive defecation syndrome includes both anorectal physiology laboratory testing and X-rays. Anal manometry will assess resting pressures and rule out hypertonia. The strain maneuver measures the pressure in the high pressure zone while bearing down. It should reduce for a few seconds while attempting to defecate. Failure to relax the sphincters is termed anismus or non-relaxing puborectalis. Although the presence

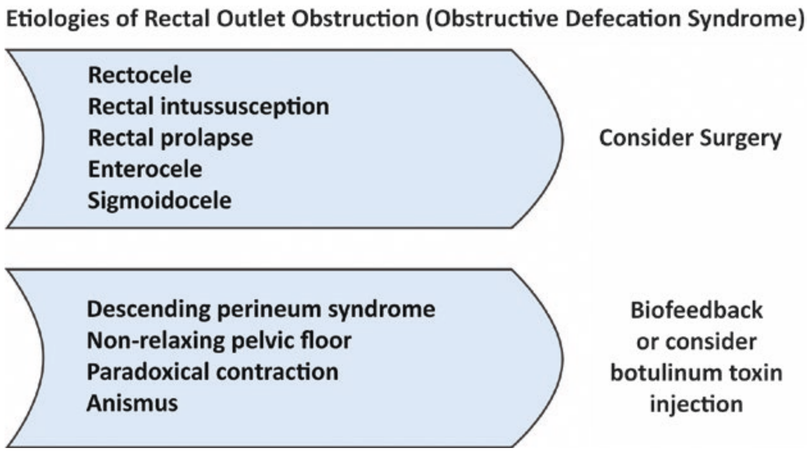

Fig. 3.4 Pathology associated with outlet obstruction. Pathologic findings are separated into those conditions for which surgery may be considered versus those conditions for which biofeedback is indicated

of a recto anal inhibitory reflex (RAIR) eliminates Hirschsprung's disease, its absence does not necessarily confirm it. However, failure to elicit the RAIR should prompt transanal full thickness rectal biopsies for confirmation. The balloon expulsion test is performed during manometry. The balloon is placed in the rectum and inflated with 50 ml of air or water (or alternatively until the patient has a sensation to defecate). Failure to evacuate the balloon within 1 min suggests outlet obstruction. In normal sized rectums, 200–250 cc of balloon inflation will elicit an uncomfortably strong urge to defecate is termed the maximum tolerated volume. Greater volume than this suggests mega rectum—a cause or consequence of outlet obstruction. EMG can complement or confirm anal manometric findings of anismus, non-relaxing puborectalis, or paradoxical contraction of the puborectalis.

Once the anorectal physiology laboratory findings suggest outlet obstruction, radiographic testing can not only verify the diagnosis but provide specific etiologies and guide treatment plans. Imaging techniques such as ultrasound (endovaginal and transperineal), MRI (dynamic pelvic floor MRI or MR defecography), and cinedefecography (dynamic defecating proctography or cystocolpodefecography) have successfully diagnosed pelvic floor disorders.

Cinedefecography, traditionally performed as dynamic defecating proctography, has long being considered the gold standard for evaluating the posterior pelvic compartment. It documents the defecatory process in real-time. By opacifying the bladder, vagina and small-bowel, cystocolpodefecography also detects abnormalities of the anterior and middle pelvic compartments. Distinct advantages are its anatomical position (patient is in a seated position), quick performance timing, and relatively low cost; a considerable dose of ionizing radiation is a distinct disadvantage.

Recently MR defecography or dynamic pelvic floor MR, has challenged cinedefecography as the new standard. It has multiplanar capability, excellent soft tissue contrast and ability to evaluate anterior, middle and posterior pelvic compartments. It offers information on both morphology and physiology with this test. Although traditionally the colorectal surgeon concentrates on the posterior pelvic compartment for analyzing disorders of defecation, the simultaneous assessment of the anterior and middle compartments may become increasingly beneficial to recognize coexisting conditions and reduce recurrences. The lack of ionizing radiation is also an advantage. Proponents, however point out that the obligatory supine position does not parallel the usual

physiological position of defecation. An open magnet would address this concern, however, their availability is relatively limited.

Various ultrasound techniques are another class of emerging technology in the diagnosis and management of outlet obstruction. Transperineal ultrasound is performed with the patient in dorsal lithotomy position after voiding. Using the ultrasound gel, the probe is placed firmly on the perineum. Both sagittal and coronal views are obtained by rotating the probe. Two-dimensional and 3-dimensional imaging is possible. Additional information is obtained by endoluminal placement of the probe into the vagina (endovaginal ultrasound). Unlike the transperineal technique, this one requires a full bladder. These ultrasounds are performed at rest, on Valsalva and during pelvic floor contraction. Although both can detect a myriad of pathology causing rectal outlet obstruction, a rectocele is best evaluated with a transperineal approach. The placement of the probe into the vagina (endovaginal ultrasound) may reduce/camouflage a rectocele. Ultrasound is the least expensive of all the aforementioned techniques. It is often better tolerated than cinedefecography or MRI. Disadvantages include the possible shifting of organ position just by the operator's placement and compression of the transducer, and the overall limited field of view compared to the other two techniques.

L. and M. The aforementioned evaluation should help categorize the patient's rectal outlet obstruction into mechanical causes (rectocele, rectal intussusception, procidentia, perineal descent, sigmoidocele and enterocele) or functional disorders (anismus, nonrelaxing or paradoxical puborectalis syndrome). This distinction is crucial since the latter generally is treated conservatively while the former are candidates for surgical intervention if conservative treatment has failed to improve symptoms (Fig. 3.4).

The following is a brief summary of the vast pathological causes of obstructive defecation syndrome and the recommended treatments.

A rectocele is defined as a herniation of the rectal wall into the posterior vagina, due to an abnormally thin, weak rectovaginal septum. It can be seen in more than 75% of parous women and rarely in men. In extreme cases, the posterior vaginal wall may protrude beyond the vaginal orifice. Symptoms do not necessarily parallel the size of a rectocele. Treatment starts with optimizing stool consistency and a trial of biofeedback to maximize pelvic floor relaxation. Surgical repair is reserved if conservative treatment failures. Although rectocele repair can be approached both transvaginally and transrectally, the former has shown superiority in select studies.

Rectal intussusception (internal or incomplete rectal prolapse) has been described in approximately 65% of patients with pelvic floor disorders. It consists of an invagination of the rectal wall that can be located in the anterior or posterior location or circumferentially. Procidentia occurs when the intussusception protrudes distal to the anal verge. Although early, minor rectal intussusception may not actually obstruct defecation, it may still lead to the debilitating sensation of incomplete evacuation. Solitary rectal ulcer syndrome may be associated with prolapse of all degrees and in extreme cases, rectal prolapse can lead to incarceration and strangulation.

Surgical repair of rectal prolapse depends on the severity of the symptoms. Any review of the literature reveals an exuberant number of surgical techniques—mainly because no single procedure addresses all issues. The higher morbidity of abdominal approaches are generally offset/rewarded with lower recurrence rates. Conversely the perineal approaches are fraught with higher recurrences yet reportedly less morbidity and mortality.

When the small bowel, or sigmoid colon herniates into the Douglas pouch, an enterocele or sigmoidocele, respectively, is formed. They are not always symptomatic, but when indicated, surgical repair is accomplished by obliterating the cul-de-sac.

A generalized weakness of the pelvic floor is referred to as descending perineal syndrome. It is diagnosed when the anorectal junction descends more than 3 cm below the pubococcygeal line. It is caused by the incessant straining associated with obstructive defecation. Pelvic floor weakness and pudendal neuropathy from childbirth trauma also contributes. Treatment generally involves biofeedback for pelvic floor strengthening while also maximizing relaxation during the strain maneuver.

Anismus, non-relaxing puborectalis (NRPR), and paradoxical puborectalis, comprise a spectrum of pelvic floor dyssynergy. Insufficient, or absence of, puborectalis muscle relaxation is the underlying pathology. It has been reported in almost half of constipated patients with outlet obstruction. Treatment, once again is conservative, with biofeedback to maximize pelvic floor relaxation. If a coexisting mechanical cause of outlet obstruction is present, conservative measures take priority over surgical ones.

If none of the pathology in Fig. 3.4 are diagnosed, continued conservative management is indicated. Along with dietary manipulation, optimization of stool consistency, empiric trial of prokinetic and biofeedback, psychosocial support can also be helpful.

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4 Mechanical Bowel Preparation for Elective Colon and Rectal Surgery

Chaya Shwaartz and Oded Zmora

Refer to Algorithm in Fig. 4.1

A. The use of mechanical bowel preparation (MBP) prior to an elective colorectal surgery was the standard of care for many years aiming to clear the bowel of fecal matter and to lower the risk of postoperative infectious complications. The initial evidence questioning the usefulness of mechanical bowel preparation has been derived from studies on the management of colorectal trauma. Multiple studies have shown that despite the fact that the colon is unprepared, the mechanism of injury is not as controlled as in elective surgery, and there is often a delay between the injury and the repair, primary repair of the colon is safe in the setting of trauma.

B. Postoperative complications such as surgical site infection (SSI) and anastomotic leak are of major concern both in emergent and elective colorectal surgery. Despite the improvement in surgical techniques, and powerful antibiotics for the control of sepsis, the rate of these complications is still high, leading to morbidity and mortality, prolonged length of stay, and higher cost. SSIs occur in about 15% of colorectal cases. Additionally, the risk for anastomotic leak is reported as between 3% to 20% following colorectal surgery, leading to a significantly higher mortality rate in these patients.

C. The use of MBP in elective colon and rectal surgery has been assessed in several single and multicenter randomized controlled trials, which showed that MBP did not decrease the risk for postoperative complications. These results led to decreasing use of MBP.

D. It seems that there is a trend towards decreased use of bowel preparation (see Algorithm in Fig. 4.1). In 2003, a survey including more than 500 surgeons (American Society of Colon and Rectal Surgeons members) showed that 98% of the surgeons participating in the survey used MBP and 75% were using oral antibiotics. A few years later (2006), a multinational survey in Europe and the US showed that 86–97% of patients received bowel preparation. In a recent large multicenter national cohort, about 50% of the patients undergoing elective colectomy received bowel preparation.

E. Recent data generated from several independent analysis of large databases show that MBP in combination with oral antibiotics is associated with reduced risk of postoperative SSI and anastomotic leak in patients undergoing elective colorectal surgery. This reduction has not been shown in randomized controlled trials.

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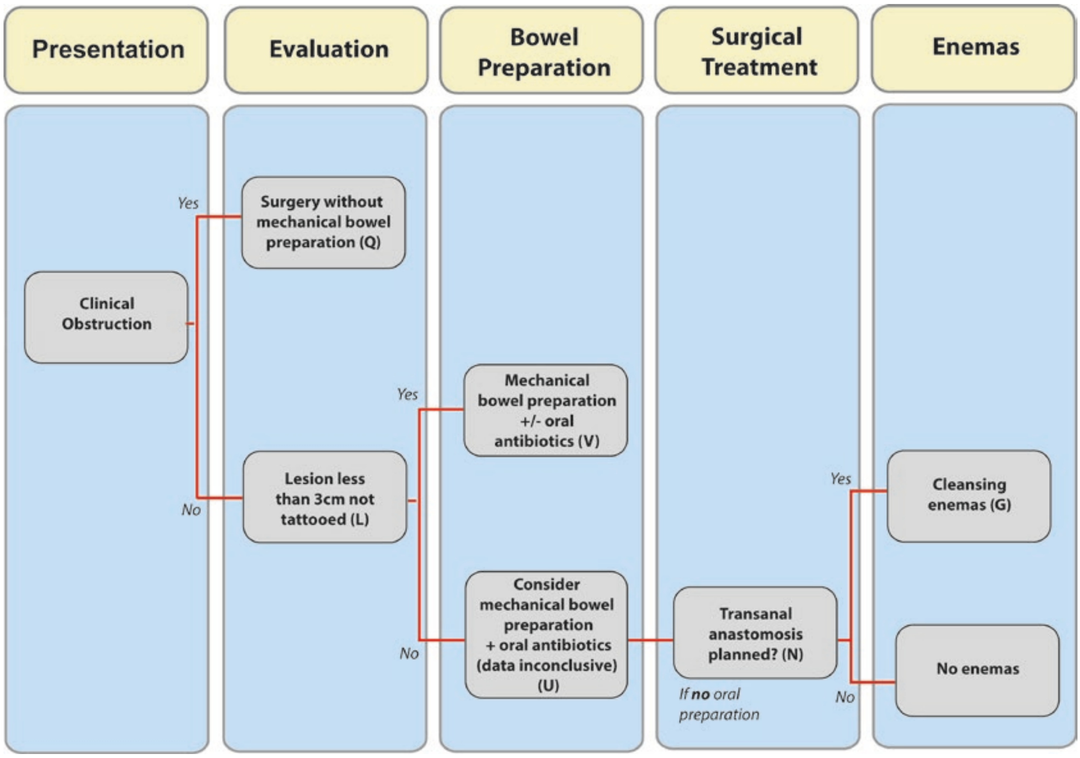

Fig. 4.1 Algorithm for mechanical bowel preparation for elective colon and rectal surgery

Single Center Studies

F. Brownson et al. were the first to publish on this topic in 1992, with their randomized trial of 179 patients to either preparation with polyethylene glycol or no mechanical preparation. This pioneer study was published as a meeting abstract, which was not followed by a full manuscript. Surprisingly, patients who had received preparation experienced a significantly increased rate of anastomotic leak and intra-abdominal infection, compared to patients without preparation. However, there was no significant difference in the rate of wound infection. This finding was followed by two studies, which were published in the 1990s by Burke et al. and Santos et al. both of which failed to show any significant difference in the intra-abdominal infection rate. However, wound infection, was more common in patients who had received mechanical preparation in the latter study.

G. Between 2000 and 2007, several larger well designed single center studies were performed. In 2003, the senior author published the largest non-multicenter study published, which included 380 patients undergoing elective colon and rectal surgery with primary anastomosis, of whom 193 were randomized to colon and rectal surgery without preoperative mechanical bowel preparation. Importantly, all patients from both groups received oral antibiotics prior to surgery. Patients undergoing rectal surgery were given one phosphate enema on the day of surgery, to avoid extrusion of stool when using a trans-anally inserted stapling device. Importantly, patients with tumors smaller than 2 cm in diameter were excluded from the study, as palpation of small tumors may be difficult in an unprepared bowel, and these patients may require intra-operative colonoscopy to identify these smaller lesions. Patients who required a diverting stoma proximal to the anastomosis were excluded from the

data analysis, thereby reducing the number of low rectal or coloanal anastomoses in this study. The two groups were well matched in parameters of demographic characteristics, indications for surgery and type of surgical procedure. There was no difference in the rate of surgical infectious complications between the two groups. Overall, infectious complication rate was 10.2% in the preparation group, and 8.8% in the non-preparation group. Wound infection, anastomotic leak, and intra-abdominal abscess occurred in 6.4%, 3.7%, and 1.1% in the bowel preparation group versus 5.7%, 2.1%, and 1%, in the no bowel preparation group.

H. Ram et al. used the exact same protocol to randomize 329 patients, and found no significant difference in infectious and overall complication rate between patients who underwent preoperative mechanical bowel preparation and those who had not, and Miettinen et al. randomized 267 patients, in a similar fashion, and found slight and non-significant increase in anastomotic leak and wound infection rates in patients who had preoperative mechanical bowel preparation. Pena-Soria et al. also presented similar results from a randomized trial including 129 patients that underwent an elective colon or proximal rectal resection with a primary anastomosis by a single surgeon.

I. Several studies suggested that when an ileocolonic anastomosis is planned, for instance, in a right, subtotal or total abdominal colectomy, surgery can be safely performed without mechanical bowel preparation. Advocates of this approach suggest that since the column of stool proximal to the anastomosis, which may mechanically disrupt the anastomosis, is avoided in these cases, mechanical cleansing may not be required. We have performed a subgroup analysis of our data, including only patients with left-sided anastomoses, in order to assess whether this type of anastomosis may be safely performed in the elective setting without mechanical bowel preparation. We included 249 patients with colo-colonic and colo-rectal anastomosis, and showed that the overall infectious complication rate was 12.5% in the preparation group, and 13.2% in the non-preparation group. Wound infection, anastomotic leak, and intra-abdominal abscess were not significantly different among the groups, occurring in 6.6%, 4.2%, and 1.6% in the preparation group, versus 10%, 2.3%, and 0.7% in the non-preparation group. Bucher et al. prospectively randomized 153 patients undergoing colon and rectal surgery with left-sided anastomosis, and found a significantly increased complication rate in patients who received mechanical bowel preparation. The overall rate of abdominal infectious complications was 22% in the preparation group and 8% in the non-preparation group, and this difference was statistically significant. Anastomotic leak occurred in 6% of the preparation group and 1% in the non-preparation group (non-significant), and mean length of hospital stay was longer for patients who had mechanical bowel preparation (14.9 days versus 9.9 days).

J. The only single center randomized study suggesting that mechanical bowel preparation given prior to colon and rectal surgery may actually lead to improved outcomes was published by Platell et al. in 2006. In this study, 335 patients were randomized to receive either oral mechanical bowel preparation using polyethylene glycol, or trans-anal preparation using phosphate enema. Patients undergoing any type of elective resection of colon or rectum with anastomosis were eligible for this study, with or without defunctioning stoma. Although there was no significant difference in overall anastomotic leak rate between the two groups, there was a significant difference in the severity of the leaks. Six out of seven patients, who developed anastomotic leak following preparation with enema only, required re-operation, as compared to none of the three patients who received oral mechanical preparation and leaked. Owing to this difference in re-operation rates, the study was prematurely terminated, before reaching its accrual goal. Three of the patients who required re-operation for anastomotic leak underwent

ultra-low anterior resection, a procedure which was not within the inclusion criteria of most other randomized trials.

K. Single center studies have the advantage of relative homogeneity of the operative and perioperative techniques, which is an important factor influencing the surgical outcome. However, assuming an infectious complication rate of 10%, designing a prospective study which will be able to detect a difference of 5% in the infection rate, in a one tailed statistical test (which only examines if the treatment is better than the control, and not the possibility that treatment is actually worse), assuming an alpha level of 0.05, with a statistical power of 90%, approximately 770 patients are required to be randomized into each group, for a total of 1540 patients. It is virtually impossible for one institution to acquire such a large number of patients in a reasonable timeframe. Thus, single center studies have the advantage of homogeneity in techniques, but usually lack sufficient power leading to type II error.

Special Considerations

Localization of Small Lesions

L. Mechanical bowel preparation may have several advantages unrelated to the risk of infection. It facilitates palpation of the entire colon during surgery, and enables the surgeon to perform intra-operative colonoscopy, if required. The intraoperative localization of small tumors may require careful palpation of the colon, which may be more difficult if the colon is loaded with fecal material. Large tumors would usually be easily distinguished from solid feces, but the identification of small tumors may be difficult. In our randomized controlled trial, we have excluded all patients with tumors smaller than 2 cm in diameter and reported no difficulties in tumor localization. Platell et al. did not exclude small tumors leading to difficulty in localization of the tumor in six patients. Thus, we strongly advise selective mechanical bowel preparation in patients with small tumors that have not been marked preoperatively with endoscopic tattoo, to allow for adequate palpation and possibly intraoperative endoscopy for tumor localization, if required.

M. In addition, the unprepared bowel does not allow palpation of the rest of the bowel to exclude synchronous lesions. In the era of modern endoscopy and other imaging techniques, the vast majority of patients have high-quality colonic workup prior to surgery, and the necessity of intraoperative palpation is thus limited. In cases where adequate preoperative full endoscopic colonoscopy or high quality virtual colonoscopy is not possible, mechanical bowel preparation should be considered.

Low Rectal or Coloanal Anastomosis

N. Most randomized controlled trials assessing the utility of mechanical bowel preparation did not include patients with low rectal or coloanal anastomosis. In our daily practice, most of the patients undergoing coloanal anastomosis concomitantly underwent temporary proximal diversion and were thereby excluded from our study. Interestingly, in the study by Platell and his colleagues, half of the patients who required re-operation for anastomotic leak underwent ultra-low rectal anastomosis with enema preparation only. Additionally, in a propensity score matching analysis by Kim et al., the authors compared the outcomes between patients receiving MBP vs. patients who did not receive bowel preparation. However, patients who underwent left-sided or rectal resection who did not receive MBP had received rectal enemas. In this study, there were significantly higher rates of severe post-operative complications in these patients compared to patients that received MBP (14% vs. 2%, $p = 0.03$). In a randomized trial, the French GRECCAR III study, it was

showed that MBP prior to rectal surgery decreases the rate of postoperative morbidity, including infectious complications. Nevertheless, the MBP was not tolerated well by the patients. Following that study, Pittet et al. conducted a matched study comparing MBP to rectal enema in patients with rectal cancer undergoing resection with primary anastomosis and protective ileostomy. The authors reported no difference between the groups in regard to the rate of anastomotic leak, pelvic abscess formation, or wound infection. Furthermore, a recent meta-analysis including 11 studies, 1258 patients, demonstrated no beneficial effect for MBP on all 30-day morbidity, anastomotic leak, and SSI in patients undergoing proctectomy.

O. Since there is not enough data to support the safety of low rectal or coloanal anastomosis without mechanical bowel preparation and at least one study raises question on its safety, we feel that caution should be taken in omitting mechanical bowel preparation in these patients. Further studies specifically addressing the safety of low rectal or coloanal anastomosis without mechanical bowel preparation are required.

Laparoscopic Colon and Rectal Surgery

P. Most of the randomized controlled trials dealing with mechanical bowel preparation for colon and rectal surgery, including the two large multicenter studies mentioned above, were limited to patients undergoing open surgery. The utility of mechanical bowel preparation in laparoscopic colon and rectal surgery may have special consideration, which may be less important with laparotomy. Mechanical bowel preparation facilitates intraoperative palpation of the colon, improving tumor localization when not evident on the serosal surface and allowing intraoperative colonoscopy in cases of uncertain localization. In laparoscopic surgery, tactile sensation is absent, and palpation of the colon is blunted. Thus, intraoperative assessment of the colon relies largely on the visual appearance of the colon during laparoscopy. Colonic pathology, however, is often confined to the mucosa, and cannot be correctly assessed by visualizing the serosal surface.

Q. To assess the safety of laparoscopic colon and rectal surgery without mechanical bowel preparation, we have retrospectively reviewed our own experience. Our policy was to give mechanical preparation to all patients with tumors smaller than 3 cm in diameter prior to laparoscopic surgery. Patients who underwent left sided colectomy had one phosphate enema prior to surgery. One hundred and thirty-two patients had laparoscopic colon resection without preoperative oral mechanical bowel preparation, 122 of them for potentially curable colon cancer. Sixteen (8%) of these patients required intraoperative endoscopy for tumor localization, all for tumors in the left side of the colon, which were successfully performed with preoperative phosphate enema preparation only. In one patient alone, conversion to laparotomy was required owing to difficulty in localization. This series suggests that with adequate selection criteria, laparoscopic colon and rectal surgery may also be safely performed without mechanical bowel preparation. Conversely, if localization had served as the main indication for mechanical bowel preparation, 131 patients in this study would have undergone preoperative bowel preparation in order to avoid one conversion.

R. Anastomotic techniques are generally performed in the same fashion whether by laparotomy or laparoscopy; therefore, the infectious complication rates should be similar as we found in our study. Chan et al. also showed similar results. Though, in a recent study by Morris et al., the authors reported that combined bowel preparation is associated with lower rates of SSI, anastomotic leak, and ileus in patients undergoing laparoscopic resection using the ACS-NSQIP data.

Technical Aspects and Spillage Control

S. Many surgeons feel reluctant to operate on patients without preoperative mechanical bowel preparation because they subjectively feel that this omission of prep may be less convenient. Besides the obvious inconvenience to the patient, mechanical bowel preparation is also associated with the risk of fluid and electrolyte imbalance and patients undergoing mechanical preparation are often dehydrated.

T. From an experiential perspective, after performing several hundreds of colon and rectal operations without mechanical bowel preparation, we can say that it is much easier to milk out solid stool away from the area of the anastomosis, and work in a cleaner field, rather than dealing with the liquid content frequently found in the colon following the use of preparation agents. Indeed, we have found that spillage of bowel content into the peritoneal cavity was significantly more common in patients who did have mechanical cleansing, and this was significantly correlated with increased risk of postoperative infectious complications.

Bowel Preparation with Oral Antibiotics Alone

U. It is controversial whether oral antibiotics preparation alone has benefit regarding postoperative complications. Cannon et al. showed that patients receiving oral antibiotics with or without MBP had significantly lower SSI rates compared to no bowel preparation (9.0% versus 18.1%; $p < 0.0001$). The authors did not find a difference between patients receiving oral bowel preparation alone and those receiving combined bowel preparation (8.3% versus 9.2%; $p = 0.47$). Lewis et al. also showed lower rates of SSI in patients receiving oral antibiotics in addition to systemic antibiotics in comparison to systemic antibiotics only. However, Scarborough et al. reported no difference in outcomes between patients receiving no bowel preparation to patients receiving oral antibiotics only. Although their analysis showed these results, the number of patients receiving oral antibiotics alone was relatively small (91 patients) and thus can subject the results to type II error. A recent RCT evaluated whether IV perioperative antibiotics are inferior to combined preoperative oral and perioperative IV antibiotics in patients with colorectal cancer undergoing surgery. The study included 515 patients that were randomized to these two groups. The authors reported no difference in the rate of SSI, anastomotic leakage, intra-abdominal abscess, adverse events and postoperative complications.

Clostridium difficile Infection

V. Several studies suggest that the risk of *Clostridium difficile* colitis following oral antibiotics alone or combined bowel preparation is not higher compared to patients who receive no bowel preparation or only MBP. A recent study by Kim et al., using the Michigan Surgical Quality Collaborative, found that the risk for Clostridium difficile infection was lower in patients receiving combined bowel preparation compared to no bowel preparation. Sadahiro et al. also showed in a prospective randomized trial that the risk of Clostridium difficile was not different between patients receiving combined bowel preparation and patients receiving no bowel preparation. However, Toneva et al. reported higher rates of Clostridium difficile colitis in patients receiving oral antibiotics. Additional studies are needed regarding the effect of oral antibiotics (with or without MBP) on the rate of Clostridium difficile infection.

Risk of Cancer Recurrence

W. In 2014, Collin et al. assessed the long-term survival of cancer patients participating in the Swedish multicenter randomized controlled

trial, using the patients' charts. Four hundred eighty-eight patients with cancer received MBP compared to 391 that underwent surgery without mechanical bowel preparation. In 10 years follow up, 80 patients (17.9%) in the MBP group and 88 patients (22.5%) in the no-MBP group developed cancer recurrence ($p = 0.093$). Cancer-specific survival was better after bowel preparation compared to no bowel preparation (84.1% versus 78.0%; $p = 0.019$), but there was no difference in overall survival (58.8% versus 56.0% respectively; $p = 0.186$). It is important to mention that the original study was not designed to assess cancer related recurrence and survival, and the mechanism of this effect of mechanical bowel preparation on cancer related survival is unclear. Two centers that have participated in the Dutch multicenter trial have assessed cancer related survival and overall survival in 382 cancer patients participating in this study, with a medial follow up of 7.6 years, and did not show such an effect of mechanical bowel preparation.

Meta-analyses of Randomized Controlled Studies

In order to overcome the low power of a single center studies, several meta-analysis of these single center studies were performed. The first review of the literature was published by Platell et al. in 1998, and included only small studies from the 1990s. Three additional meta-analyses were published in 2004 and 2005. In addition, a Cochrane systematic review regarding bowel preparation was performed in 2005 and was updated in 2009. This review included a total of 13 RCTs with 4777 participants, and included the two multicenter randomized trials mentioned below; 2390 allocated to MBP, and 2387 to no preparation, before elective colorectal surgery. In this analysis, there was no statistically significant difference in overall anastomotic leak rate between patients that received MBP compared to patients that did not receive bowel preparation (4.2% versus 3.4%; OR 1.26; 95% CI: 0.941–1.69). Interestingly, there was no difference in anastomotic leak rate in patients that underwent low anterior resection with and without MBP (10% versus 6.6%; OR 1.73; 95% CI: 0.73–4.10). Additionally, there was no difference in the rates of wound infection between the two groups (9.6% versus 8.3%; OR 1.19, 95% CI: 0.98–1.45).

Slim et al. reviewed seven randomized controlled trials with 1464 patients. In this meta-analysis, mechanical bowel preparation was significantly associated with increased rate of anastomotic leak. Interestingly, the authors of this meta-analysis separately assessed the four studies that used polyethylene glycol for oral preparation, and those that used other oral agents. They found that whereas the use of polyethylene glycol was associated with increased risk of anastomotic leak, the pooled data of the studies that used different agents did not show significant difference in anastomotic leak rate.

In 2012, the enhanced recovery after surgery society (ERAS) stated that bowel preparation should not be routinely used in colonic surgery, since randomized controlled studies failed to show beneficial effects, and showed potential adverse effects such as dehydration, postoperative ileus, and patient discomfort.

Although meta-analysis of several randomized controlled studies has the power to compare a large group of patients, may have a major drawback due to the heterogeneity in methods and included populations in the different studies.

Multi-center Studies

Although several single center studies suggested that mechanical bowel preparation is not useful in preventing complications in colon and rectal surgery, these studies included an insufficient number of patients needed to draw meaningful conclusions. Thus, multicenter studies with a large number of patients were needed to demonstrate generalizability of these results. In 2005, Fa-Si-Oen et al. presented a multicenter, randomized trial comparing the outcomes in 250 patients undergoing open colon surgery with and without

bowel preparation. The authors found no difference in rates of wound infections (7.2% vs. 5.6%, p = 0.61) and anastomotic leaks (5.6% vs. 4.8%, p = 7.78) between patients receiving mechanical bowel preparation and patients without preoperative preparation of the bowel. However, this multicenter study also suffered from insufficient statistical power.

The first published large and well powered multicenter randomized controlled trial is a Swedish trial, which was published in June 2007. The study included 1505 patients undergoing elective open surgery for cancer, adenoma, or diverticular diseases with primary anastomosis in 20 Swedish and 1 German colorectal units, of which 1343 were eligible for data analysis. Six hundred eighty-six patients were randomly assigned to have preoperative mechanical bowel preparation and 657 patients were assigned to have no mechanical preparation. The agents used for mechanical preparation was not standardized, and was based on local protocol of each participating unit. Polyethylene glycol was used for preparation in 47% of the patients and sodium phosphate in 48.5%. Preparation with enema only was used in the remaining patients. All the patients received intravenous prophylactic antibiotics, but the selection of antibiotic agent was according to each participating unit protocol. Anastomotic leak was diagnosed in 2.3% of the patients who had the mechanical preparation, and in 2.6% of the patients without the preparation. There were no significant differences between the groups in the rates of cardiovascular, general infectious or surgical site infectious complications. The type of oral agents used for bowel preparation had no effect on the incidence of cardiovascular, infectious or surgical site complications. The authors of this study concluded that the collective evidence from this and other trials strongly suggest that mechanical bowel preparation is of no benefit in terms of anastomotic healing or infection rates, or for improving the overall postoperative course in patients undergoing colon resection; thus, this practice should be abandoned.

The second multicenter randomized controlled trial was from the Netherlands. In this trial, 1431 patients undergoing elective open colon and rectal surgery with primary anastomosis were randomized to mechanical preparation or no mechanical preparation. The incidence of anastomotic leak was similar in the two groups, 5.4% in patients who did not have mechanical bowel preparation and 4.8% in patients who did have mechanical preparation. There was no significant difference in other septic complications or mortality. Again, the authors of this study concluded that elective colon and rectal surgery can be safely carried out without mechanical bowel preparation, and therefore mechanical bowel preparation should be abandoned.

Kim et al. have recently reviewed the Michigan Surgical Quality Collaborative–Colectomy Best Practices Project between 2007 and 2011. This retrospective cohort study compared postoperative complications in patients receiving full bowel preparation (mechanical bowel preparation and oral antibiotics) versus matched patients who did not receive bowel preparation, and included a total of 1914 patients in the analysis. Patients receiving full preparation were less likely to have any SSI (5.0% versus 9.7%; P = 0.0001), organ space infection (1.6% versus 3.1%; P = 0.024), and superficial SSI (3.0% versus 6.0%; P = 0.001). Patients receiving full preparation were also less likely to develop postoperative Clostridium difficile colitis (0.5% versus 1.8%, P = 0.01). This study suggests that mechanical bowel preparation combined with oral antibiotics was useful in elective colorectal surgery.

Moghadamyeghaneh et al. used the American College of Surgeons National Quality Improvement Program (ACS-NSQIP) to evaluate the association between bowel preparation and postoperative outcomes in patients with colon cancer undergoing resection during 2012 to 2013. This retrospective study included 5021 patients and compared between patients who received combined bowel preparation to patients who received MBP only, oral antibiotics only, and patients who received no bowel preparation

at all. The authors reported no decrease in complication rate in patients receiving MBP only or oral antibiotics only compared to patients who received no bowel preparation at all. Interestingly, this finding was true for both left and right side colon resections. However, patients who received combined bowel preparation (MBP and oral antibiotics) had significantly lower rates of overall morbidity ($p < 0.01$), superficial SSI ($p < 0.01$), anastomotic leak ($p < 0.01$), and intra-abdominal infections ($p < 0.01$). Likewise, Scarborough et al. reported similar results, using the ACS-NSQIP data. They showed that the risk for SSI and anastomotic leak is significantly lower in patients undergoing colorectal surgery for diverticular disease, cancer, and non-malignant polyps who received combined bowel preparation. Also in 2015, Morris et al. reviewed the ACS-NSQIP data as well and compared the postoperative outcomes between patients receiving MBP only, combined bowel preparation, and no bowel preparation who underwent colon resection. They found similar results, with lower rates of SSI, shorter length of stay, and lower readmission rates in patients receiving combined bowel preparation compared to no bowel preparation or MBP only.

A recent multicenter randomized trial from Finland randomized 396 patients undergoing colorectal surgery with anastomosis for preoperative mechanical bowel preparation and oral antibiotics. Approximately half of the patients had right-sided colectomy. There was no significant difference in anastomotic leak rate, surgical site infection, and overall complication rate between the two groups. Although this study may be underpowered to detect small differences, it does put into question the benefit of the combined mechanical in oral antibiotic preparation which has been suggested by studies generated from large databases.

Thus, despite the limitations of databases, the most recent data show clear benefits to the routine use of a combination of oral and cathartic antibiotic bowel preparation.

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5 Perioperative Assessment and Risk Stratification

Debbie G. Bakes and Laurence R. Sands

Refer to Algorithm in Fig. 5.1

A. **History and Physical Examination**

There is no substitute for a thorough medical history and performing a thorough physical examination in every patient seen in clinic especially those undergoing surgery. The history of a surgical patient obviously focuses on the disease process being addressed. However, this time is also the opportunity for the surgeon to gain a thorough understanding of the comorbidities and coexisting medical conditions that may impact the outcome of the intended procedure. Cardiac conditions, the use of medications that impact wound healing such as steroids and biologics, bleeding disorders and the use of antiplatelet medications are just some of the major potential issues.

Physical examination while focused on the colorectal pathology, should be complete. A head to toe survey can alert the surgeon to important comorbid conditions that may be undiagnosed and ultimately impact the outcome of the procedure. Carotid bruits, cardiac arrhythmias and murmurs, lower extremity edema, and signs of significant peripheral vascular disease are an important part of the preoperative assessment.

B. **Basic Testing**

Most patients undergoing surgical procedures will require some basic laboratory and diagnostic testing. The nature of these tests will vary depending on the surgical procedure being performed, the age, sex, and overall health of the patient. Here is list of the basic testing and the indications for each of these studies.

1. Chest Radiograph (CXR) - is indicated only if patients are experiencing active pulmonary symptoms or undergoing intrathoracic procedures. It is not even required in patients with a history of smoking, a history of TB, or patients with stable COPD.
2. Electrocardiogram (EKG) - is not required based on age alone and is not needed in low risk procedures in the absence of cardiac disease. If an EKG is done it should be done within 6 months of upcoming surgery and all AICD and pacemakers should be interrogated within 6 months of the planned colorectal surgery and all AICD and pacemakers should be interrogated within 6 months of surgery.

   An EKG is only required in the following circumstances:

(a) Poorly controlled hypertension
(b) History of angina or angina equivalent (shortness of breath)

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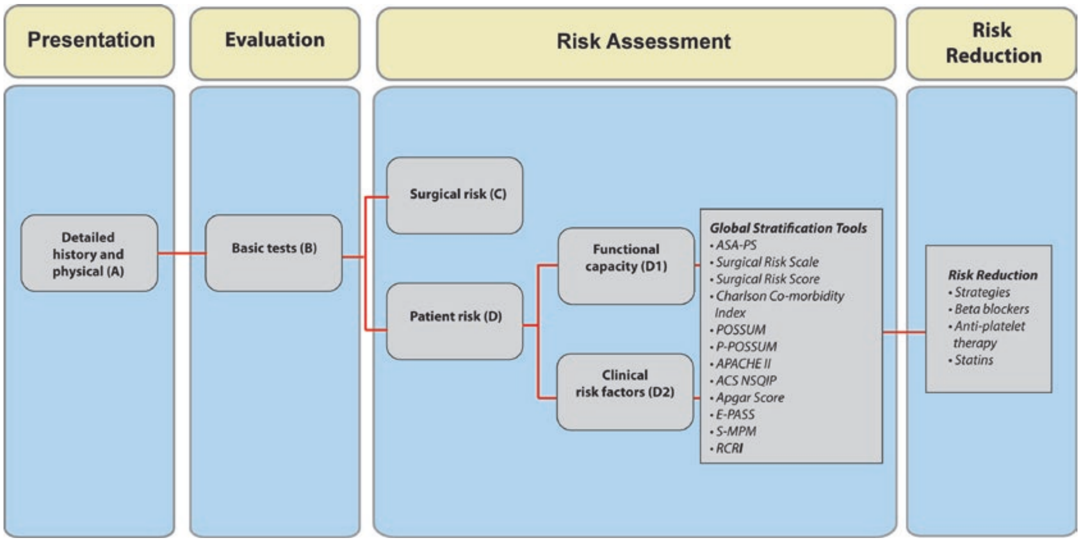

Fig. 5.1 Algorithm for perioperative assessment and risk stratification

  (c) Previous history of myocardial infarction
  (d) History of stroke or peripheral vascular disease
  (e) History of chronic renal insufficiency or creatinine >2
  (f) History of diabetes
  (g) History of drugs that may affect cardiac status
  (h) Poor functional status
  (i) Patient undergoing vascular surgery
3. PT/INR and PTT are only indicated if:
  (a) There is a personal or family history of bleeding disorders
  (b) The patient has known liver disease
  (c) The patient uses anticoagulation medication sin which case this test should be ordered in the morning of surgery
  (d) The patient is undergoing brain or spine surgery
4. Platelet count should be ordered within 4 months of surgery if:
  (a) There is a history of abnormal bleeding
  (b) There is a history of hematologic malignancy
  (c) There is evidence of thrombosis, purpura, or petechiae
  (d) There is a history of radiation or chemotherapy
5. CBC should be ordered if:
  (a) The anticipated surgery expects a blood loss of more than 500 ml
  (b) The patient donated blood within the last 2 months prior to surgery
  (c) There is a history of anemia, leukemia, or cancer
  (d) There is a history of bleeding, renal, or liver disease
  (e) The patient is using anticoagulants
6. Serum chemistry should be ordered in the following patients:
  (a) Patients with a history of diabetes, hypertension, renal disease, CAD
  (b) The patient is taking medications that may alter electrolytes
  (c) Those with history of liver disease, chronic alcohol use, or hepatotoxic drugs
  (d) Those with known thyroid disease or history of palpitations, sweating, heat or cold intolerance, weight gain or loss, excessive hair loss (in these cases thyroid function tests should be ordered)
7. Urinalysis should be obtained if:
  (a) Prosthetic materials are to be used during surgery

   (b) The patient is undergoing prostatectomy
   (c) The patient has a symptomatic UTI
8. Pregnancy Test should always be ordered for:
   (a) Any female of childbearing age
   (b) Any patient undergoing a total abdominal hysterectomy or gynecological procedure

      This test does not need to be done if the patient cannot conceive
9. Type and screen should be drawn:
   (a) If there is a reasonable probability that a blood transfusion will be required
   (b) A Type and Cross should be done if a blood transfusion is expected

C. **Surgical Procedure Risk Assessment**

Different surgical procedures have different inherent risk depending on the type of procedure being performed. Several factors play a role in this determination. The anticipated length of the procedure, the complexity of the operation, anticipated fluid shifts, blood loss and the need for general anesthesia all impact the inherent risk of the planned procedure. Stratification leads to three categories of procedures being performed: low risk, intermediate risk, or high risk (Table 5.1). These categories are determined by the probability of having a Major Adverse Cardiac Event (MACE). While no specific category is given to laparoscopic cases, laparoscopy may erroneously be thought of as a lower risk procedure. However, lengthy operative times, extreme positions, and the cardiac implications of intra-abdominal pressure changes associated with laparoscopy should be considered.

D. **Patient Risk Assessment**

When determining the risk of a planned intervention, two items must be considered: the intended procedure and the patient undergoing the stated procedure. A relatively low risk procedure may actually become a high-risk situation depending on the clinical status of the patient. In deciding which preoperative studies should be performed, the patient's risk must be identified. The functional capacity or self-reported exercise tolerance is a good predictor of surgical outcome. Several indices have been used to measure this such as the Duke Activity Status Index (Table 5.2) and the specific activity scale. This assessment measures the patient's ability to climb 1–2 flights of stairs or walk several blocks at 4 mph. Patients with good exercise tolerance have a good prognosis even with stable cardiac disease and will often not require further cardiac testing. Poor performance on these gross assessments (less than 4 metabolic equivalents) of functional status may alert the physician to consider further testing. The Duke Activity Status Index has even been compared to measuring various biomarkers such as high sensitivity C-reactive protein (hsCRP), B-type natriuretic peptide (BNP), creatinine, fasting lipid profiles, apolipoprotein A1 (apoA1), and apolipoprotein B

Table 5.1 Surgical procedure risk assessment

Low risk	Intermediate risk	High risk
MACE <1%	MACE 1–5%	MACE >5%
Superficial surgery	Intrathoracic	Major vascular repair
Breast surgery	Intraperitoneal (Gallbladder)	Major abdominal surgery
Dental procedures	Carotid Endarterectomy	Esophagectomy
Cataract surgery	Endovascular repair	Pneumonectomy
Endoscopic procedures	Head and neck surgery	Pulmonary or liver transplant
Thyroid surgery	Neurologic or ortho major	Adrenal resection
Minor GYN procedures	Urologic or GYN major	Total cystectomy
Minor orthopedics	Renal Transplant	
Minor urologic (TURP, TURBT)		
Cosmetic/reconstructive surgery		

Table 5.2 Duke activity status index

Can you	Weight
1. Take care of yourself: eating, dressing, bathing or using the toilet?	2.75
2. Walk indoors, such as around your house?	1.75
3. Walk a block or two on level ground?	2.75
4. Climb a flight of stairs or walk up a hill?	5.50
5. Run a short distance?	8.00
6. Do light work around the house like dusting or washing dishes?	2.70
7. Do moderate work around the house like vacuuming, sweeping floors, or carrying in groceries?	3.50
8. Do heavy work around the house like scrubbing floors or lifting or moving heavy furniture?	8.00
9. Do yard work like raking leaves, weeding, or pushing a power mower?	4.50
10. Have sexual relations?	5.25
11. Participate in moderate recreational activities like golf, bowling, dancing, doubles tennis, or throwing a baseball or football?	6.00
12. Participate in strenuous sports like swimming, singles tennis, football, basketball, or skiing?	7.50
Total score:	DASI scoring: Positive responses are summed to get a total score, which ranges from 0 to 58.2. Higher scores indicate higher functional capacity and lower incidence of MACE.

(apoB). The activity index has greater relevance predicting major adverse cardiac events after surgery than biomarkers. However, there are studies suggestive that higher serum levels of natriuretic peptides, particularly BNP and N-terminal-pro-BNP, which are secreted by myocardium into the circulation in response to ischemia and stretching of the heart wall are significant markers of cardiovascular risk and complications after non-cardiac surgery. High sensitivity cardiac troponin may also be an indicator of increased risk of postoperative myocardial infarction and mortality.

Other tests that may provide additional preoperative cardiac assessment include resting echocardiograms, cardiac stress tests and CPET. The echocardiogram has not been shown to offer any advantage of reducing postoperative cardiac events over the basic clinical exam and overall patient assessment. Routine exercise stress testing is predictive of a good outcome if the patient can achieve more than 7 METS on the examination. In addition, areas of reversible ischemia are associated with increased cardiac risk. CPET has also been used as an objective measure of cardiac and pulmonary fitness in some centers but there is a lack of evidence to support routine use of these exams.

More objective parameters in the clinical evaluation may lead the surgeon to an in depth cardiac evaluation. These include a known history of coronary artery disease, heart failure, arrhythmias, and valvular heart disease. A myocardial infarction (MI) within 6 months of elective surgery is one of the most significant risks of postoperative cardiac events. As the length of time between the MI and surgery increases, the risk of a postoperative cardiac event will decrease. Current guidelines suggest that non-urgent surgery should be delayed at least 60 days after an MI if no coronary intervention has been performed. Symptomatic patients with valvular stenosis, particularly aortic stenosis, may also pose a significant risk of cardiac events. Several scoring systems have been developed to quantify this risk. The American Society of Anesthesiologists (ASA) Score was devised in 1963. The ASA score is a subjective assessment of a patient's overall health that is based on five classes (I to V) (Table 5.3).

Emergency surgery (E) is placed after the Roman numeral if the procedure being done requires that it be performed emergently.

Table 5.3 American Society of Anesthesiologists (ASA) Score

ASA	
I	Patient is a completely healthy fit patient.
II	Patient has mild systemic disease.
III	Patient has severe systemic disease that is not incapacitating.
IV	Patient has incapacitating disease that is a constant threat to life.
V	A moribund patient who is not expected to live 24 h with or without surgery.

These cases may pose greater risk to the patient but will not allow a more substantial preoperative evaluation due to the urgent nature of the case. Emergent cases should be done as safely as possible to allow for the best possible outcome. In these cases, patients should be given adequate fluid resuscitation prior to surgery as well as proper prophylaxis with antibiotics and anticoagulation to prevent deep vein thrombosis. The rate of postoperative complications has been closely related to ASA classification with the more complicated patients (ASA IV) having a 23-fold rate of complications compared to the simpler (ASA I) patients. ASA however does have limitations. It does not account for the age, weight, sex, anesthesiologist or surgeon skill, pregnancy, or preoperative resuscitation of the patient undergoing surgery. In addition, the words "systemic disease" may not account for a recent myocardial infarction as it may instead represent a local disease.

The Revised Cardiac Risk Index (RCRI) (Table 5.4) has been validated as a tool to predict perioperative cardiac complications. This relatively simple scale may provide some insight into perioperative cardiac complications. Glance and his colleagues developed the Surgical Mortality Probability Model (S-MPM) because many clinicians who use the Revised Cardiac Risk Index do not account for the non-cardiac causes that may account for perioperative mortality. Their 9-point 30-day mortality risk index includes ASA physical status (I—0 points, II—2 points, III—4 points, IV—5 points, V—6 points), emergent nature of the intended surgery (1 point for emergent surgery), and surgery risk class (low—0 points, intermediate—1 point, or high—2 points). Point totals less than 5 were associated with a mortality of less than 0.5% while scores over 6 were associated with 10% mortality. The advantage of the S-MPM system is the relative ease of calculation and use along with its validity.

Table 5.4 Revised cardiac risk index

1. History of ischemic heart disease
2. History of congestive heart failure
3. History of cerebrovascular disease (stroke or transient ischemic attack)
4. History of diabetes requiring preoperative insulin use
5. Chronic kidney disease (creatinine >2 mg/dl)
6. Undergoing supra-inguinal vascular, intraperitoneal, or intrathoracic surgery
Risk for cardiac death, nonfatal myocardial infarction, and nonfatal cardiac arrest: 0 predictors = 0.4%, 1 predictor = 0.9%, 2 predictors = 6.6%, ≥3 predictors = >11%

E. **Other Global Patient Assessment Tools**

There have been many different patient assessment systems that have been devised to assess patient risk prior to surgery. The purpose of these tools is to allow the physician to provide proper informed consent for the upcoming surgical procedure, guide clinical decision making in the preoperative period, and thereby improve surgical outcomes. The many systems that are currently in use are quite varied. While some systems strictly make use of preoperative values, some use intraoperative data as well as postoperative variables that can all affect patient outcomes. The problem with adding intraoperative and postoperative variables is that they are of little value to the practicing physician when they are seeing a patient in the office prior to surgery and trying to provide guidance to the patient as to what tests or assessments the patient will require prior to the intended procedure.

The most common validated tools currently used for preoperative risk stratification include ASA-PS (Physical Status) (Table 5.3), the

Surgical Risk Scale, the Surgical Risk Score, and the Charlson Comorbidity Index. The Surgical Risk Scale and the Surgical Risk Score both include the ASA-PS while they also consider the urgency and the severity of the intended surgical procedure. Tools that also consider intraoperative events and postoperative data include the Physiological and Operative Score for the enUmeration of Mortality and Morbidity (POSSUM) and the Portsmouth variation of POSSUM (P-POSSUM). Another tool, the Acute Physiology and Chronic Health Evaluation II (APACHE II) considers a measure of acute physiology and chronic health when evaluating patients as it also utilizes the patient's physiologic results within the 24 h of critical care admission. Even more confusing is that some of these validated scoring systems, use subjective data such as the interpretation of chest X-rays, perhaps making the tools less effective.

The American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) Surgical Risk Calculator is an instrument that employs 21 preoperative risk factors. This calculator allows a Surgeon Adjustment Score that can be modified by the physician's clinical impression. While this scoring system can predict risk for many different surgical procedures, it can more specifically predict the risk and complications including potential returns to the OR for 10 different CPT codes for laparotomy. It has not been found to be as predictive in emergent situations.

An Apgar score has also been described for surgical procedures. This scoring system measures blood loss, the lowest heart rate and the lowest mean arterial pressure. It is based on a 10-point scale as the one used in childbirth for newborns. Scores less than or equal to 4 are associated with worse outcomes. The limitation to this scoring system is that it is only useful as a predictor after surgery and is not a valid tool to be used for preoperative risk assessment since its metrics are all based upon operative events. It too has a limited role in emergency procedures.

The Estimation of Physiologic Ability and Surgical Stress (E-PASS) scoring system was developed to account for patient's reserve and surgical stress to calculate a morbidity and mortality. This system uses two parts to derive at a comprehensive score. The first part uses a preoperative risk scoring system that accounts for age, the presence or absence of heart disease, pulmonary disease, diabetes, as well as a performance status index, while the second part uses a surgical stress scoring system which is calculated based upon the amount of blood loss, the patient's body weight, the operative time, and the extent of the skin incision. As the comprehensive score rises, so does the complication and mortality rates. The E-Pass, while specifically designed for gastrointestinal surgery, has yet to be validated in large multicenter trials.

In summary, there are many risk stratification scales and scores that have been developed. The physician must decide which system best suits their practice so that they can properly inform their patients of the appropriate risks of surgery and guide them to the tests required so they may have the best clinical outcomes.

F. **Risk Reduction Strategies**

There have been several strategies proposed to help eliminate cardiac risk in those patients undergoing non-cardiac surgery. While many of the methods used today consist of medical therapy some have questioned the benefits of undergoing prophylactic coronary artery bypass surgery prior to having elective major surgery. The CARP trial demonstrated no mortality reduction associated with the performance of prophylactic coronary artery bypass surgery in patients with stable coronary artery disease who were to undergo major elective vascular surgery. In addition, the DECREASE V trial did not show any additional reduction in death and MI undergoing coronary revascularization in high-risk vascular surgery patients with extensive stress-induced ischemia especially if tight heart rate control was also achieved with beta blockers.

In patients with bare metal stent placement, dual antiplatelet therapy (DAPT) should be continued for 4–6 weeks before non-cardiac surgery. If a drug eluting stent has been placed, DAPT should be continued for 6 months, or a minimum of 3 months if the risk of delay exceeds the risk of an ischemic event.

Perioperative beta-blocker usage is associated with a lower incidence of non-fatal MI, but higher incidence of bradycardia, hypotension, and stroke. The American College of Cardiology (ACC) recommends that beta-blockers should be continued in patients taking them chronically. In addition, they suggest that beta blocker therapy should begin even one day prior to surgery in patients with cardiac ischemia or more than 3 cardiac risk indices (see Table 5.4).

The benefit of statins has also been called into question. Statins have been shown to stabilize plaques thereby preventing plaque rupture and thus lowering the risk of myocardial infarction. The American College of Cardiology recommends that statins be continued in patients chronically taking them and to begin therapy for patients undergoing vascular surgery and those with other clinical indications such as diabetes, coronary artery disease, peripheral arterial disease and hyperlipidemia while undergoing high-risk procedures (see Table 5.1).

The decision to use aspirin must be made on a case-by-case basis weighing the risks of a cardiovascular event against the risks of perioperative bleeding. The POISE 2 trial compared those patients already on aspirin therapy to those who were aspirin naïve. There was no benefit in terms of reducing MI or death but those on aspirin had an increased risk of bleeding with the highest risk seen in those started earlier on aspirin.

G. **Special Considerations**

With the incidence of obesity on the rise and more of these patients requiring surgery, we must consider certain aspects in the preoperative evaluation specific for this patient population. Once again, a careful history and physical examination should be performed focusing on the presence or absence of sleep apnea and the need for spirometric studies in those with this condition. An EKG should be obtained if there are risk factors that mandate this exam. Fasting blood sugars should also be assessed to rule out metabolic syndromes.

Immunosuppressed patients are evaluated in the same manner as those who are immunocompetent. If the patient is taking chronic steroids prior to surgery, then the patient should be given stress steroid dosing at the time of the surgery. Fasting blood sugar levels should also be monitored. While patients taking anti-TNF agents do not require additional preoperative testing, they have been associated with a higher risk of postoperative infectious complications remote from the surgical site as well as overall complications and these patients should be counseled accordingly. If feasible, stopping anti-TNF 2 months prior to surgery would be ideal to decrease this rate and improve postoperative outcomes.

Summary

While the majority of the preoperative evaluation is now undertaken by internists and anesthesiologists in Preoperative Assessment Clinics (PAC), it remains the responsibility of the attending surgeon to ensure that the patients are properly counseled as to the operative risk for patients undergoing elective non-cardiac surgery. The surgeon needs to have a good understanding of the multitude of tests and stratification systems available preoperatively to ensure patient safety for the best possible outcome. Risk reduction strategies should be considered carefully and implemented whenever possible for patients undergoing surgery.

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Enhanced Recovery Pathways in Colorectal Surgery

6

Sherief Shawki, David Liska, and Conor P. Delaney

Introduction

The traditional model of perioperative patient management relies on surgical, anesthesia, and other involved teams, providing care in a separate and individualized manner. The specific care provided depends on practice preferences of the various individual members of the healthcare teams involved. Collectively, this created significant variation in patient care, which had the potential to lead to worse patient outcomes and increased health expenditures. Enhanced recovery pathways (ERPs), are standardized, multidisciplinary approaches to perioperative care designed to guide health care teams towards collaborative care, based on a combination of evidence-based interventions. The goal is to minimize the patient's physiologic stress response to surgery and thereby allow for rapid recovery to baseline function. The different phases of perioperative care, including preoperative optimization, intraoperative care, and post-operative recovery are integrated into a single patient-centered pathway, allowing for decreased variability and costs, and improved outcomes. In colorectal surgery and in many other disciplines, the efficiency of patient care, accelerated recovery, and reduction in length of stay achieved by ERPs has been shown not to compromise patient safety or lead to an increase in readmission rates. An important component of ERPs, running parallel to these three phases of care, is an ongoing audit and evaluation of outcomes and value provided by the pathway. Figure 6.1 illustrates the flow and different components of ERPs as described below.

A. Preoperative Management

Refer to Algorithm in Fig. 6.1

Patient Education and Engagement

In ERPs the patient is an integral part of the process and rather than being a passive recipient, is an active participant in their own recovery process. To manage expectations, education of patients and their caregivers must start in the preoperative phase and should include a clear explanation of the perioperative care plan. Besides the traditional explanations regarding the disease, surgical plan, and risks associated with the surgery, patients should be provided with information about postoperative expectations, including daily goals/milestones regarding pain management, physical activity, and diet. Providing effective patient education is an acquired skill, and providing simple yet comprehensive materials is extremely helpful. The criteria for hospital dis-

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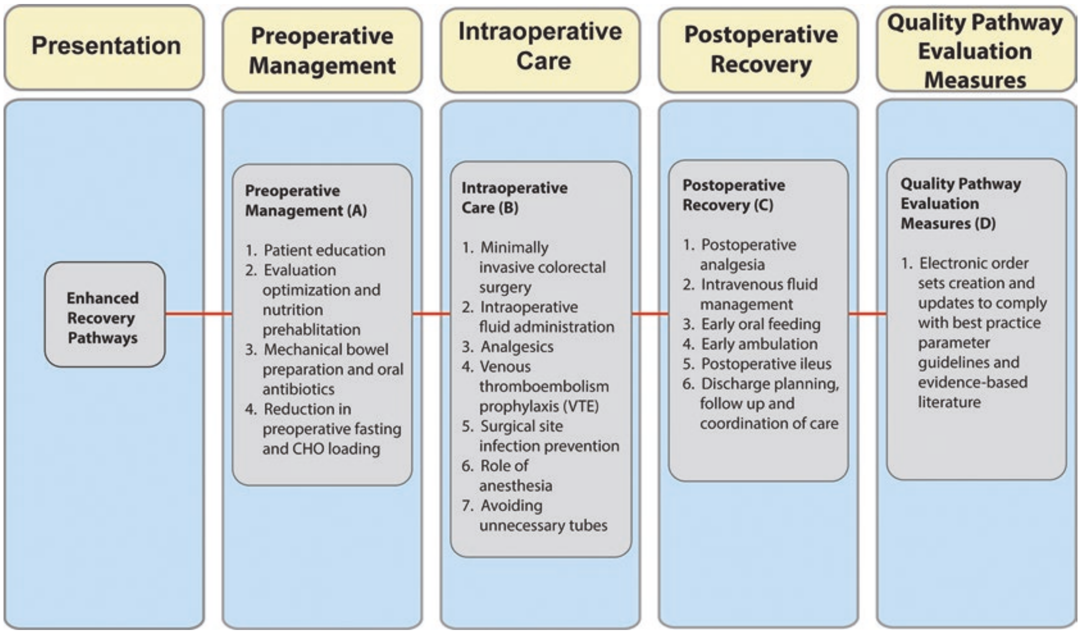

Fig. 6.1 Algorithm for enhanced recovery pathways for colorectal surgery

charge should also be explained during this phase as a way of setting realistic expectations for patients, emphasizing that their active involvement can improve outcomes. Establishing a good patient-healthcare team relationship and providing a solid method of communication can aid in developing patients' trust in the process, reduce patient anxiety and may alleviate unnecessary readmissions.

Evaluation, Optimization, Nutrition and Prehabilitation

Modern practice of surgery views the patient as a whole, since other factors, beyond surgical techniques, can often significantly contribute to patient outcomes. The principal goal of preoperative optimization is to target patients with preexisting functional compromise in whom physiologic reserves can be improved to better withstand the stress of the planned surgery. Social and behavioral factors that can influence recovery, such as illicit drug use, tobacco smoking, and alcohol dependency should also be addressed.

Poor nutritional status leads to increased susceptibility to infection, poor wound healing, and is associated with worse postoperative outcomes including increased morbidity and length of stay (LOS). Therefore, malnutrition should always be screened for in-patients undergoing colorectal surgery. Several validated tools can be used to identify poorly nourished patients preoperatively. One of which is the patient-generated Subjective Global Assessment (SGA) which assesses nutritional status based on features of the history and physical examination and categorizes patients into well nourished (SGA-A), moderately nourished (SGA-B), and severely malnourished (SGA-C). Nutritional optimization for 2–3 weeks, preferably via the enteral route, has been shown to improve outcomes in malnourished patients. Recent studies have shown that perioperative intake of nutritional supplements enriched with arginine and fish oils ("immunonutrition") can reduce the incidence of postoperative infectious complication, especially, in high risk patients. A recent meta-analysis of 27 randomized controlled trials assessing the role of immunonutrition in patients undergoing surgery for gastrointestinal malignancies found that perioperative enteral immunonutrition significantly reduced the incidence of postoperative infectious complications when compared to with standard enteral nutrition (RR, 0.46; 95% CI, 0.34–0.62).

The body's capacity to compensate for the stress induced by surgery relies on its physio-

logical reserve. Frailty, defined as globally reduced physiologic reserve, is frequently present in the elderly or other patients who harbor multisystem impairment, or are functionally deconditioned at baseline. These patients are at increased risk for postoperative complications, and prolonged recovery and LOS. Prehabilitation is a structured process aiming at increasing patients' physiological reserve in anticipation of an upcoming stressor and thereby reduce postoperative morbidity and accelerate recovery. There are several different assessments and indices available to help measure the degree of frailty for risk stratification. The 11-variable modified Frailty Index (mFI) is one such tool that, based on the patient's baseline functional status and comorbidities, identifies those who could benefit from preoperative prehabilitation. The mFI assigns a score from 0 to 11, with a score of 0 signifying the absence of frailty, whereas a score of 11 equals maximum frailty. Recent studies demonstrated that about 61% of postoperative patients with mFI of 0–1 (an increase in the mFI score implies increased frailty) spent 1–3 days in the hospital, while more than 50% of patients with mFI of 3 or more were hospitalized between 4 and 8 days. Further studies suggest that a 4-week period of prehabilitation can improve walking capacity in colorectal cancer patients, with deconditioned patients making the biggest gains. However, these functional gains have not yet been shown to lead to improved perioperative outcomes and further studies are needed.

Preoperative optimization also extends to include disease-specific and lifestyle modifications in patients with comorbidities such as diabetes mellitus, chronic obstructive lung disease and congestive heart failure. Occasionally, optimization by a specialist is recommended. Smoking also imposes risks to postoperative pulmonary status, incisional healing and anastomotic integrity. One study found that patients who underwent smoking cessation at least 4 weeks prior to surgery had better outcomes than a reference cohort of patients that did not participate in cessation programs. Similarly, increased alcohol consumption (>3 ETOH units/day) been associated with increased complications, and preoperative alcohol cessation may result in decreased complications.

Additional data is needed to justify the allocation of resources toward creation of a structured program that combines preoperative exercise training, nutritional support, and optimization of chronic disease processes, although such a practice appears rational for preoperative optimization.

Mechanical Bowel Preparation and Oral Antibiotics

The role of mechanical bowel preparation (MBP) in reducing intra- and post-operative complications in colon and rectal surgery had been an area of debate with multiple prospective studies showing no difference in outcomes when MBP is used. However, many of these trials did not include oral antibiotics. In U.S clinical trials, mechanical bowel preparation combined with oral antibiotics has consistently been found to decrease infections rates. Furthermore, with mechanical bowel preparation intraoperative laparoscopic manipulation of the bowel, specimen extraction through small incisions, and performing stapled anastomoses is easier and less traumatic. It is therefore our practice for all colorectal resections to routinely prescribe preoperative mechanical bowel preparation in combination with oral antibiotics consisting of neomycin and metronidazole.

Reduction of Pre-operative Fasting and Carbohydrate Loading

Traditional preoperative preparation included patient fasting after midnight on the day of surgery, to reduce the risk of aspiration during the induction of anesthesia. This resulted in a prolonged period of time for the patient without hydration or nutrition. Mechanical bowel preparation, with the resulting diarrhea and fluid shifts, can further increase the risk for dehydration in these patients that can in turn lead to hypotension upon induction of anesthesia due to vasodilation. Furthermore, thirst and hunger, rank among the most common complaints patients have before surgery. Studies have shown that the intake of clear fluids up to 2 h before surgery does not increase gastric volumes

and the risk for aspiration in patients without underlying gastroparesis. Therefore, current anesthesia guidelines prohibit solid food intake for 6 h before elective surgery, but encourage clear liquid intake until 2 h before surgery.

Recent studies have evaluated the effect of oral supplementation with carbohydrate rich drinks before surgery on the patient's postoperative metabolic state. Several studies have shown that carbohydrate loading prior to elective surgery, by administration of a complex carbohydrate-rich drink (100 mg the evening before surgery and 50 g 2–3 h prior to anesthesia), increases insulin sensitivity. Insulin resistance is a recognized risk factor for the development of postoperative complications. While physiological data supports the concept of carbohydrate loading, it is not yet clear if reducing insulin resistance in turn results in improved clinical outcomes such as decreased postoperative complications and LOS. Thus, further investigation is needed to better define the role of preoperative carbohydrate loading, and whether there is any improvement over placebo. However, irrespective of the proposed benefits on postoperative outcomes, preoperative carbohydrate loading may also decrease anxiety, and reduce hunger and thirst while waiting for surgery, thereby improving patient satisfaction.

B. Intraoperative Care

Minimally Invasive Colorectal Surgery

While laparoscopic colorectal surgery and ERPs result in improved outcomes independently, there is a synergistic effect when both are combined together resulting in the shortest hospital stay, averaging 2.6 days, with some patients being discharged within 24 h. Other benefits include faster regain of bowel motility, earlier tolerance of solid oral intake and having bowel function. A Cochrane review of 3 RCTs and 6 control studies confirmed the above mentioned outcomes without an increase in patient morbidity. Reduction in hospital stay and early discharge did not have an impact on readmission rate. The laparoscopic approach has also been shown to reduce the risk of infectious complications. It is now well established that minimally invasive surgery results in improved perioperative outcomes and accelerated recovery from surgery. Prospective randomized controlled trials have also shown that, in colon cancer surgery, long term oncologic outcomes are similar between the laparoscopic and open approach. Due to inconclusive results of recent trials examining the role of laparoscopy in rectal cancer, the optimal approach to rectal cancer is still a matter of debate. However, in experienced hands with documented good oncologic outcomes, the laparoscopic approach in rectal cancer has also been shown to improve early postoperative outcomes and accelerate recovery.

Intraoperative Fluid Administration

Perioperative fluid homeostasis is influenced by surgical stress induced hormonal changes. Historically, fluid resuscitation was based on often overestimated requirements, which translated into early postoperative weight gain secondary to fluid retention and third spacing. In elective bowel surgery, fluid overload of as little as 3 L may result in increased complication rates and a narrow range fluid balance should be the goal (indicated by minimal weight gain on POD1; <2.5 kg). Restrictive fluid resuscitation strategies have demonstrated a decrease in cardiopulmonary complications and LOS (as few as 2.7 days) without an adverse effect on anastomotic leakage or surgical-specific complications. Prolonged fasting and bowel preparation should be considered during resuscitation due to the associated fluid deficits. Intra-operatively, identifying patients' needs based on indices reflecting real-time volume status can assist in tailoring intraoperative fluid resuscitation that minimizes fluid overload. Tools such as transesophageal probes, central venous catheters, and finger probes can use circulatory parameters as surrogates of real-time volume status to guide volume repletion. The use of invasive tools should be selective and

the cost of newer non-invasive cardiac output measuring tools still needs to be justified by evidence demonstrating improved outcomes. The current state of the literature would suggest that goal-directed fluids tend to improve outcomes when the control group has neither goal-directed fluids, nor an event related potentials (ERP). Trials comparing goal-directed fluids vs placebo in patients on enhanced recovery pathways for intestinal surgery tend to show no improvement with GDFT. Similarly, postoperatively, the use of maintenance intravenous fluids should be judicious and based on objective indices including, but not limited to, urinary output, serum creatinine, and blood urea nitrogen.

Analgesia

In ERPs pain control is envisioned as one continuum rather than separate pre-, intra- and postoperative phases. The goal is to achieve adequate postoperative pain control to accomplish daily activity milestones such as ambulation and deep breathing while minimizing the development of adverse effects, such as nausea, vomiting, ileus, hypotension, and/or kidney injury, among others. It is often helpful to discuss and review the proposed postoperative regimen and set appropriate expectations prior to surgery. For better efficacy, pain control should start during the perioperative phase. Suppressing nociceptors prior to surgical pain stimulus has been shown to reduce postoperative narcotic requirements. This “preemptive” analgesia includes a spectrum of analgesia ranging from oral medications starting the day prior to surgery, to neuroaxial blockade via placement of epidural catheter, or spinal analgesia prior to the procedure, to local infiltration of surgical sites prior to incision as in laparoscopic surgery. Non-steroidal anti-inflammatory drugs (NSAIDs) such as ibuprofen, ketorolac, or celecoxib are administered on the day of surgery. Acetaminophen and gabapentin are both given in the preoperative stage. Peripheral nerve blockade using transverse abdominis muscle plane (TAP) block have shown to decrease postoperative opioid usage without many of the side effects associated with epidural analgesia. It is a technically simple, easy to learn, low-cost procedure and can easily be performed under laparoscopic or ultrasound guidance. In our practice, we have not favored the use of epidurals, as there is no clear evidence of them helping in the setting of an enhanced recovery pathway, and two randomized trials we have performed and several meta-analyses show no improvement.

Multimodal pain control regimens should be tailored towards each patient based on patients’ history of chronic narcotics usage, liver and kidney function, age, and type of surgery.

Venous Thromboembolism Prophylaxis

According to Surgical Care Improvement Project (SCIP) guidelines pharmacological venous thromboembolism (VTE) prophylaxis should be given within 24 h of surgery, and it is our practice to administer 5000 units of unfractionated heparin prior to induction, in addition to the use of sequential compression devices (SCD). Mechanical and pharmacological VTE prophylaxis is routinely continued postoperatively until discharge. Early post-operative mobilization has been shown to dramatically reduce the incidence of VTEs. Both unfractionated heparin and low molecular weight heparin (LMWH) can be used with data showing no significant difference between both prophylactic agents. When epidural catheters are used for analgesia, timing of the administration of heparin needs to be coordinated to minimize the risk of bleeding during placement and removal of the catheter. Current guidelines recommend extending postoperative VTE chemoprophylaxis for up to 4 weeks in high risk individuals such as cancer patients undergoing major abdominopelvic surgery. Other high risk conditions that may benefit from extended VTE prophylaxis include morbid obesity, limited mobility, history of prior VTE or PE, and possibly inflammatory bowel disease. Patients going

to skilled nursing facilities should also be considered to be high risk.

Surgical Site Infection Prevention

Surgical site infections (SSI) are the most common surgical complications and are associated with increased morbidity, length of stay, and readmissions. Emerging data supports the implementation of bundled evidence-based interventions to reduce the risk of SSI. Important bundle elements include: mechanical and antibiotic bowel preparation (discussed previously), appropriate skin preparation, use of wound protectors, and preoperative intravenous antibiotics. Administration of preoperative systemic antibiotics has been shown to reduce the incidence of SSI. SCIP guidelines recommend that antibiotics be given within 1 h prior to surgical incision and that prophylactic antibiotics be discontinued within 24 h of surgery. In colorectal surgery, appropriate antibiotic selection requires adequate coverage of aerobic and anaerobic flora and while considering a patient's allergies. Antibiotics need to be re-dosed if the procedure lasts longer than two half-lives of the selected agent. We favor a single dose at induction of anesthesia, re-dosing for longer procedures.

Meticulous skin preparation with an appropriate agent is another critical component of SSI prevention. A large randomized controlled trial compared Chloraprep (2% chlorhexidine gluconate and 70% isopropyl alcohol) to povidone-iodine in clean-contaminated cases. Patients in the Chloraprep group had significantly lower incidence of superficial and deep SSI. Small randomized controlled trials and a recent meta-analysis have shown that the use of wound-protectors is associated with nearly a 50% reduction in SSI in gastrointestinal surgery. Other measures that are recommended to reduce the incidence of SSI, include maintaining perioperative normothermia, euglycemia, and euvolemia. To achieve optimal results, it is important to standardize care and incorporate these individual best-practice measures as part of a bundle within an ERP.

Role of Anesthesia

An anesthesia team can contribute tremendously towards more efficient ERPs, as the team is actively involved in different aspects including preoperative evaluation, attenuation of surgical stress, appropriate fluid management, proper analgesia, maintaining acceptable blood glucose level, and pre-emptive treatment of postoperative nausea and vomiting (PONV). Strategies to prevent PONV include: avoiding nitrous oxide and volatile anesthetics, using propofol for induction and maintenance of anesthesia, and minimizing intraoperative opioids. Another key aspect of PONV prevention is the prophylactic treatment with antiemetics such as dexamethasone and ondansetron, especially in patients at high risk for PONV. Another important intraoperative aspect is maintenance of normothermia. Hypothermia induced shivering and associated vasoconstriction trigger body stress response and been associated with increased SSI. Residual post-operative paralysis from neuromuscular blockade can be difficult to recognize and has been shown to increase complications and ICU admissions. Good communication between the surgery and anesthesia teams about the progression of the case allows for improved timing of the administration of paralytics and reversal agents to minimize any residual post-operative paralysis. In general, ongoing open communication between surgeon and anesthesiologist is critical to achieve compliance with ERP measures and prevent complications.

Avoiding Unnecessary Tubes, Drains, and Lines

Current literature has shown that the routine use of nasogastric tubes does not prevent post-operative complications such as ileus, anastomotic leaks, pulmonary complications, or SSI. In fact, avoiding prophylactic placement of nasogastric tubes (NGT) in gastrointestinal surgery is associated with accelerated regain of bowel function and less pulmonary complications. Early removal of Foley catheters is recommended to reduce postoperative urinary tract infection rates.

For some procedures, the catheter may be removed as early as immediate postoperatively prior to leaving the operating room. Post-void residual monitoring protocols using bladder scan may be used to rule out urinary retention while straight catheterization is used as needed.

C. Postoperative Recovery

Postoperative Analgesia

As discussed above, a comprehensive multimodal approach to analgesia should start in the pre-operative phase. While preemptive analgesia is started preoperatively, achieving adequate pain control becomes one of the critical milestones for recovery in the postoperative phase. There is a fine line between maintaining adequate pain control, promoting recovery, and patients' satisfaction while preventing side effects, tolerance, and abuse. The main goal of multimodal pain management strategies is to adequately control pain while minimizing the use of opioids. There are a variety of non-opioid bases strategies that can be incorporated in this approach including: Acetaminophen, NSAIDs, gabapentinoids, systemic lidocaine, anti-NMDA agents such as Ketamine, wound infiltration with local anesthetics, abdominal trunk blocks, and spinal or epidural anesthesia. Thoracic epidural analgesia (TEA) has been shown by some studies to provide improved pain control while decreasing the need for systemic opioids and accelerate gastrointestinal recovery, but only if those epidurals are opioid-free. Many published ERPs and guidelines include TEA as a cornerstone of multimodal pain management. However, randomized controlled trials have shown that within the context of an ERP, TEA does not result in earlier discharges or decreased complications. In fact, in laparoscopic colorectal surgery, studies have shown that in the context of an ERP, TEA actually delays hospital discharge and increases the risk for complications such as urinary retention and hypotension. In our practice, epidurals are only used selectively in patients undergoing open surgery based on patient history of chronic opioid use or patient preference. For both laparoscopic and open procedures, our routine post-op order sets include around the clock acetaminophen PO, ketorolac IV (transitioned to ibuprofen PO on day 2), gabapentin PO, and as needed oxycodone PO or hydromorphone IV. Systemic patient controlled analgesia (PCA) with hydromorphone is used selectively, in patients requiring frequent IV breakthrough medications and discontinued as soon as tolerated. Acetaminophen and ibuprofen are continued after discharge with oxycodone for breakthrough pain, with the instruction to wean off narcotics as soon as possible.

Intravenous Fluid Management

Judicious administration of intravenous fluids continues in the postoperative phase, with data indicating that restricting intravenous fluids to less than 2 L/day is associated with faster recovery of gastrointestinal function, increased gastric emptying, and overall less morbidity and LOS. With the demonstrated safety and feasibility of early oral intake, ERPs allow for decreased intravenous fluid usage. Most patients who are tolerating *ad lib* oral liquids on postoperative day one should not require any supplemental fluids. On the other hand, in patients who develop a post-operative ileus with nausea and vomiting, or high stoma output, excessive fluid losses should be judiciously repleted. Unless otherwise indicated, intravenous fluids should be minimized or stopped within postoperative day 1–2.

Early Oral Feeding

While traditionally, patients were kept fasting postoperatively until demonstrating return of bowel function, ERPs have dramatically changed post-operative care by allowing early initiation of postoperative diet. Early postoperative feeding has been shown to be safe and feasible in about 70–90% of patients without increasing the risk of aspiration pneumonia. Furthermore, early feeding seems to decrease insulin resistance, hyperglycemia, and wound infection rates. Early restarting

oral intake within first day of surgery has been integrated in many institutional ERPs without delay in discharge. It is important to bear in mind that nausea, vomiting, and postoperative ileus still occur in a proportion of patients, generally in the order of 5–10%. Patients need to be monitored for these symptoms and in cases of ileus with significant gastric distention, management with prompt nasogastric tube insertion is required.

Early Ambulation

Early mobilization and ambulation is an important step in accelerating postoperative recovery and is a critical component of ERPs. Early ambulation is also a marker of success of the program due to successful preoperative patient preparation and proper pain control. It promotes early return of bowel function and prevents pulmonary complications, reduced work capacity, and loss of muscle mass associated with prolonged bed rest. Patient compliance and motivation can be improved by setting out daily goals in the preoperative phase that are then reinforced with posters or signs on the ward.

Postoperative Ileus: Prevention and Treatment

Postoperative ileus, characterized by a transitory cessation of normal bowel function, is one of the most common complications following colorectal surgery resulting in prolongation of hospital stays and readmissions. Despite a lack of an accepted uniform definition for what constitutes a POI or prolonged POI, it is estimated that it occurs in approximately 10–15% of patients undergoing colorectal surgery. POI is a significant cause of healthcare expenditure, accounting for approximately $750 million per year. Many of the important components of ERPs described above aim to enhance and accelerate recovery by reducing the incidence of POI. Minimally invasive surgery, early post-op mobilization and nutrition, opioid sparing strategies, and avoiding fluid overload have all been shown to accelerate recovery of bowel function. There is conflicting data on whether gum chewing accelerates return of bowel function and decreases LOS in the context of an ERP. However, some benefit was noted with gum chewing and it is an inexpensive and well tolerated intervention. In terms of pharmacological interventions, despite laxatives (such as bisacodyl and magnesium oxide) and prokinetic agents (such as metoclopramide and erythromycin) frequently being used for the prevention and treatment of POI, data are limited and no impact on LOS was demonstrated. Randomized controlled trials evaluating alvimopan, a peripheral-acting mu-opioid receptor antagonist, have shown a decrease in the time to return of gastrointestinal function and a decrease in POI and LOS after open colorectal surgery with a primary anastomosis. These benefits have been shown to offset the cost associated with the drug and in fact result in overall significantly decreased hospital expenditures. While some retrospective studies support the use of Alvimopan in laparoscopic bowel resections, there is no convincing evidence that it is beneficial and cost-effective in laparoscopic colorectal surgery in the context of an ERP. Thus, we use alvimopan for patients undergoing segmental resection, and give a single dose to laparoscopic patients at high risk of conversion to open surgery, stopping the medication if the operation is completed laparoscopically.

As discussed previously, there is no role for nasogastric tube insertion as a preemptive measure to prevent PONV or POI. However, for the treatment of POI, nasogastric decompression and short-term bowel rest are established measures to comfort the patient and avoid aspiration.

Discharge Planning, Follow-Up, and Coordination of Care

Integral to any ERP are clearly formulated discharge criteria that are understood by the patients and all care providers, including trainees and nurses. In this way, patients are continuously evaluated for discharge readiness as early as on the first day after surgery. Discharge criteria for open and laparoscopic surgery are identical.

Patients should be discharged when they are tolerating a diet, pain is controlled with oral medications, vital signs are stable, bowel function (including stoma output) is appropriate, and any home going needs have been addressed. Careful preoperative evaluation of frailty allows for the identification of patients at risk for increased nursing and rehabilitation needs at discharge. Arranging post-discharge care pre-operatively, can help prevent any prolongation of hospitalizations for these high risk patients. For all patients, it is important to establish follow-up appointments and coordination of care with primary and other involved healthcare providers prior to discharge. Post-discharge phone calls can help identify patients who would benefit from earlier follow-up to address questions or complications that can be addressed in the ambulatory setting and thereby prevent emergency room visits and readmissions.

D. Quality Pathway Evaluation Measures

Various members and teams contribute to patient care include surgeons, anesthesiologists, residents, nurse practitioners, physician assistants, nurses, ostomy and wound care team, physical therapy, and social workers. One important method to ensure efficient process flow while eliminating variability and facilitating compliance with an ERP is the utilization of electronic medical records. The capability of creating order set(s) during many phases of patient care, provides a reproducible blueprint that is a key in maintaining consistent, standardized care. Compliance with the designed ERP and optimization of individual measures within the ERP depend on continuous audit of processes and outcomes. Especially for newly designed ERPs, monitoring of outcomes and costs associated with the pathway are critical to demonstrate the value to patients, physicians, and the institution. Participation in quality improvement projects, such as the well-described American College of Surgeons (ACS) national quality improvement project (NSQIP), has been shown to significantly reduce morbidity and mortality. The Enhanced Recovery in NSQIP (ERIN) is a new collaborative to help teams implement colorectal pathways including measures such as multimodal analgesia, early nutrition and ambulation, and goal directed fluid management. Besides participant "buy-in" to allow for pathway implementation, sustainability is just as important in achieving long-term enhanced value through ERPs. Audit with continual monitoring and analysis of outcomes is essential to maintain the improvements that are provided by ERPs. Compliance with the individual pathway elements needs to be monitored, analyzed, and corrected as needed. The most important outcomes that need to be measured are LOS, perioperative complications (using a standardized scoring system such as the Clavien-Dindo classification), and readmissions. The safety and efficacy of ERPs has been demonstrated in numerous randomized controlled trials and meta-analyses. It is critical for each institution and surgical team to demonstrate that the implemented pathway replicates the results observed in trials and to optimize processes based on real-life data.

Conclusion

A successful surgical practice relies on the delivery of patient-centered, high-quality care, prompting the need to integrate all elements of perioperative patient care, eliminate variability of practice, and engage patients and their caregivers in the effort to improve outcomes. ERPs are a multimodal and interdisciplinary evidence-based approach resulting in standardization of patient care, minimizing variability, and maximizing efficiency and value. Well-designed ERPs cover the whole health care episode, and result in a reduction in morbidity and mortality, decreased length of hospital stay without an increase in readmission rates. Accomplishing these goals directly benefits not only patients but also helps to improve the efficiency with which healthcare is provided by decreasing length of hospital stay (LOS) and costs associated with complications.

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7 Hematochezia and Melena

Anjali S. Kumar and Jennifer Ayscue

Refer to Algorithm in Fig. 7.1

Types and Assessment (Table 7.1)

A. Melena

Melena is defined as the passage of black or tarry stools. The black color of melena is a result of the oxidizing effects of the intestinal and bacterial enzymes on heme that produce hematin. This finding can occur with the loss of as little as 50 ml of blood and can persist for as long as 5 days after the actual bleeding event. Stool could remain positive for occult blood several weeks after a bleeding episode. Melena can be associated with blood loss anywhere along the gastrointestinal (GI) tract from the mouth to the ascending colon. Black stools may also result from iron intake, consumption of dyes, such as tannins in red wine or the reaction of intestinal contents with bismuth in over-the-counter chewable antacids.

B. Minor/Moderate Hematochezia

Hematochezia (*Greek haima = blood, chez(ein) to defecate*) means the passage of bright red, easily identifiable blood or blood clots from the anus. Sometimes hematochezia and melena are interchanged mistakenly and can lead to confusion regarding the proper meaning of these terms.

We divide acute hematochezia into "severe" and "moderate" bleeding because the management of these patients differs.

Anoscopy is a crucial part of the initial evaluation. If the patient is young with a recent onset of hematochezia consisting of "wipe" bleeding or blood in the toilet with bowel movements and symptoms attributable to hemorrhoids or an anal fissure, it is reasonable to begin a trial of conservative therapy appropriate to the diagnosis (see Fig. 7.2, below). In the absence of pathology seen on anoscopy, an in-office rigid proctoscopy can be performed after administration of an enema. Some offices are equipped with in-office endoscopy, in which case a flexible sigmoid proctoscopy can be considered. If these in-office attempts fail to declare a source of bleeding, the patient should be set up for an elective colonoscopy +/− upper endoscopy.

C. Severe Hematochezia. +/− Hematemesis

For the purposes of this discussion, "severe" bleeding means that the patient bleeds more than 1500 ml in 24 h or has signs of shock on admission. These patients have a risk of exsanguination.

Resuscitation of the patient is imperative to prevent shock. After resuscitation, it is often possible to continue with diagnostic

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Ulcer Characteristics	Prevalence Rate	Rebleeding Rate	Surgery Rate	Mortality Rate
Clean base	42%	5%	0.5%	2%
Flat spot	20%	10%	6%	3%
Adherent clot	17%	22%	10%	7%
Visible vessel	17%	43%	34%	11%
Active bleeding	18%	55%	35%	11%

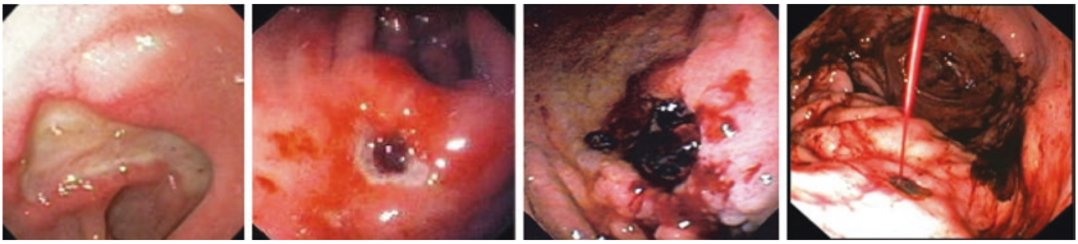

Fig. 7.1 Ulcer characteristics and correlations

Table 7.1 Types of anorectal, lower gastrointestinal, small bowel bleeding and melena and evaluation

Risk assessment at presentation	Evaluation (in this order)
Melena [A]	1. History and physical exam 2. Colonoscopy 3. Esophagogastroduodenoscopy (EGD) 4. Enteroscopy
Minor/moderate hematochezia [B]	1. History and Physical Exam 2. Anoscopy 3. In-office proctoscopy (rigid or flexible) 4. Colonoscopy
Severe hematochezia [C]	1. Fluid/blood product resuscitation to point of hemodynamic stability 2. History and Physical Exam 3. Nasogastric Tube (NGT) Lavage Test 4. EGD 5. Colonoscopy (rapid prep) 6. Enteroscopy

maneuvers. However, it may be necessary to proceed with the diagnostic procedures at the same time as the resuscitation if the bleeding continues. Fortunately, colorectal bleeding seldom leads to an uncontrollable situation and will stop spontaneously in about 70–80% of cases; therefore, generally there is time for diagnosis and treatment.

Along with the standard clinical examination, if there is no perineal pain, it is mandatory to perform anoscopy and rigid proctoscopy after an enema.

History can elicit if the patient has previously experienced hematochezia (consider chronic causes), prior diarrhea (consider inflammatory bowel disease) or has known liver disease with impaired coagulation. Use of anticoagulant therapy or nonsteroidal anti-inflammatory drugs (NSAIDS) are all important clues to the etiology and possible therapeutic options. Dates and findings of the last endoscopy performed are useful.

In the case of a patient with a known aortic aneurysm repair who has severe hematemesis,

prompt attention by the vascular surgery service may be lifesaving.

Upper endoscopy should be performed if clinically indicated and technically feasible. At the very least, a nasogastric tube should be inserted and bilious non-bloody drainage confirmed. If the colonoscopy fails to reveal the site of bleeding and the bleeding has stopped, a lavage-type (i.e., rapid) bowel preparation can be given and a more thorough colonoscopy is repeated either later the same day or the next day.

Refer to Algorithm in Fig. 7.2

Melena Caused by Upper Gastrointestinal Bleeding

D. Pre-malignant/Malignant Lesion (Found on Endoscopy)

Endoscopy may reveal a bleeding polyp, or a gastric, duodenal or small bowel neoplasia. While small polyps may be amenable to endoscopic treatment alone, malignant pathology will require biopsy, staging work up, multidisciplinary tumor board discussion and consideration of treatment options (neoadjuvant therapy, surgery, adjuvant therapy) as appropriate for the lesion.

E. Variceal

Massive hematemesis due to esophageal varices is, perhaps, the most dreaded sequela of portal hypertension. Overall, ~90% present with hematemesis. This problem most commonly occurs secondary to hepatic cirrhosis, although it may also be due to pre- and post-hepatic obstructive phenomenon. As always, initial stabilization of the patient is the first goal, and often requires a significant transfusion requirement. Patient mortality with an acute bleed from esophageal varices approaches 50%. This high fatality is related not only to the severity of the bleeding but also to the underlying nutritional, hepatic and pulmonary dysfunction encountered in these patients.

Therapy is guided by endoscopic evaluation of the varices since as many as half of the patients with known cirrhosis and active GI bleeding have sources of hemorrhage other than their varices at the time of acute GI bleeding. Control of the hemorrhage can be accomplished using endoscopic techniques, systemic pitressin therapy, beta-blockade, placement of a Sengstaken Blakemore tube, or utilization of a trans-jugular intrahepatic portosystemic shunt (TIPS).

Surgical options include a nonselective end to side portocaval shunt, which is technically simpler but has a high incidence of encephalopathy or a side to side portocaval or mesocaval shunt. Options to be considered in the more elective setting include distal splenorenal shunts with total pancreatic disconnection in patients with adequate liver reserve, and liver transplantation in carefully selected patients with poor liver function.

F. Non-variceal

The most common cause of upper GI bleeding are peptic ulcer disease (PUD) 45%. Esophageal varices is 20%, gastritis is 20%, and Mallory-Weiss tear is 10%

PUD affects approximately ten million Americans. It is most common in male smokers between the ages of 20 and 60 years.

Gastric ulcers are mostly related to mucosal barrier breakdown. Types (1) normal fundic ulcer, (2) gastric and duodenal ulcer, (3) pre-pyloric ulcer, (4) juxto-cardiac ulcer. Approximately 85% of ulcers will improve with conservative medical treatment. However, it is important to obtain biopsies and washings as well as to consider re-endoscopy to confirm healing in any questionable lesion since 10% of ulcers are malignant. Medical management should also include treatment for *H. pylori*.

Endoscopic treatment should control 90% of these lesions.

Medical treatment includes H2 histamine blockers, volume resuscitation correction of coagulation defects, and careful hemodynamic monitoring. Patients who should be considered for surgical intervention include those whose initial bleeding episode lead to syncope or hypotension, persistent slow

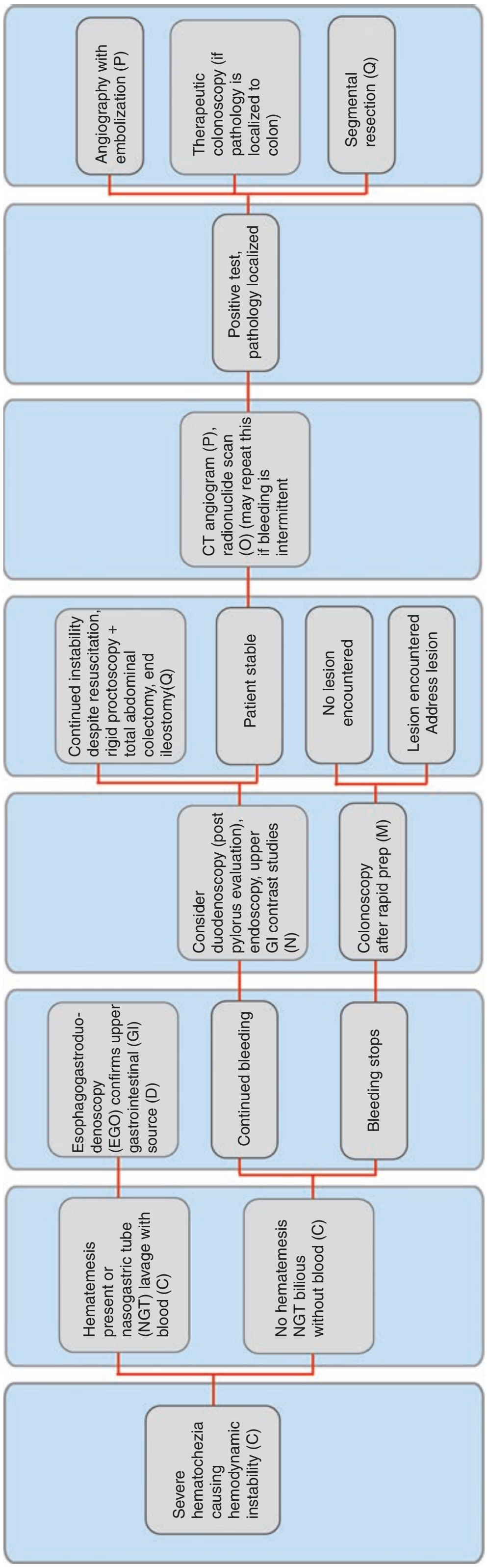

Fig. 7.2 Algorithm severe hematochezia causing hemodynamic instability. *NGT* nasogastric tube

bleeding lasting >24 h while on appropriate treatments, loss of >1500 ml of blood during an 8-h period, requirement of >6 units of blood, a second acute episode while in the hospital or the endoscopic presence of predictors of high-risk re-bleeding (Table 7.1). Within this latter category are a giant duodenal ulcer >2 cm, a visible vessel with a clot, or active bleeding not amenable to endoscopic control.

Vagotomy should be added to treatment of Type II and Type III gastric ulcers.

Gastritis is commonly associated with shock, sepsis, burns (Curling's ulcer) and CNS problems (Cushing's ulcers). Although gastritis was once a common and often lethal problem in the ICU setting, its incidence has decreased due to the prophylactic use of antacids and enteral nutritional support.

Mallory Weiss tears are longitudinal tears in the gastric mucosa at the level of the GE junction most often related to forceful emesis. Average length of the tear is 2 cm. 15% of patients may have 2 or more tears. These lesions most often stop spontaneously and the associated mortality in non-cirrhotic patients is essentially 0%.

Angiodysplasia, which is synonymous with arteriovenous malformation and vascular ectasia, can be found in 2% of individuals older than 50. The bleeding, which comes from venule dilation, is responsible for 30% of all colon bleeds. Almost 80% of these vascular malformations are found in the right colon, but they can also be found in the small bowel in younger patients. There is an association with aortic stenosis and von Willebrand disease

G. Mass

Hemangiomas and leiomyomas are the most common masses responsible for bleeding. Other less likely etiologies include lipomas, fibroadenomas, hamartomas, sarcomas and adenocarcinomas. Regardless, these masses usually require operative resection after appropriate preoperative staging and therapy.

Refer to Table 7.3

Hematochezia Caused by Anorectal Bleeding

H. Pruritus

Anal itching, or perineal dermatologic disorders, can cause minor anorectal bleeding. The diagnosis is usually one of exclusion. In severe cases, a biopsy may be needed to rule out more sinister pathology. Typically, non-operative interventions such as changes in diet and hygiene, barrier creams or short-course topical anti-inflammatory agents will diminish the bleeding.

I. Fissure

Anal fissures are usually associated with pain; yet in some cases, chronic fissures can manifest as bleeding without in the absence of pain. The bleeding, however, is typically associated with bowel movements, though when it occurs between bowel movements, it is usually self-limited. Treatment for anal fissures is covered in Chap. 10 of this book, for the purposes of the bleeding workup, as with the other anorectal pathologies discussed below, it is critical to rule out a more proximal source.

J. Anal Mass

Warts (i.e., condyloma) can be friable at the base, and are not necessarily associated with pain, but will be palpable on digital examination. HPV-related precancerous lesions are typically not associated with masses and will also not bleed, but the invasive type will result in a mass-effect and occasionally bleeding.

K. Hemorrhoids

Internal hemorrhoidal disease can bleed without pain or masses (Table 7.4 and Fig. 7.2). It is important to distinguish rectal varices due to cirrhosis from hemorrhoids before any office-based procedures (such as banding) are considered.

L. Proctitis

Inflammation of the rectal wall can cause bleeding. This can be caused by infection

Table 7.2 Evaluation of melena to rule out an upper gastrointestinal bleeding source

Evaluation	Risk assessment	Pathology (category)	Specific diagnosis	Treatment
EGD	Benign	Variceal [E]	Esophageal varices Gastric varices	β-Blockade Somatostatin Endoscopic banding TIPS Sengstaken-Blakemore Tube
Colonoscopy		Non-variceal [F] 1. Arterial 2. Arteriovenous malformation (AVM); Dieulafoy lesion 3. Venous	Ulcers • Duodenal • Gastric • Esophageal Inflammation • Gastritis • Esophagitis Deep mucosal tears (Mallory-Weiss tear) Telangiectasias Angioectasias	Intravenous proton pump inhibitor (PPI) Treat H pylori Endoscopic treatments • Clips • Bands • Argon plasma coagulation • Heater probe • Laser photocoagulation • Bipolar electrocautery • Injection – Epinephrine – Thrombin – Sclerosants
Enteroscopy	Premalignant/ Malignant [D]	Mass [G]		Excision, resection

Table 7.3 Hematochezia caused by anorectal bleeding (see also Table 7.2)

Evaluation (in this order)	Diagnosis	Management
External exam (visual inspection)	Pruritus [H] Anal Fissure [I]	Non-surgical Management/Medical Topical Therapy Office-based intervention Surgical procedures
Digital Anorectal Exam	Mass [J]	Excision/biopsy
Anoscopy	Hemorrhoids [K]	
In-office proctoscopy (rigid/ flexible)	Proctitis [L] • Radiation • Inflammatory bowel disease (IBD)	Topical therapies Supportive therapies Systemic therapies Resection (if severe)
All above negative, proceed with endoscopy performed under sedation	Colonoscopic findings [M] • Ischemia • Prolapse • AVM • IBD • Diverticulosis • Neoplasm	Refer to respective chapters on these topics If these diagnoses are not encountered on endoscopy but bleeding persists, follow algorithm for severe hematochezia

Table 7.4 Anorectal and lower gastrointestinal bleeding guide for clinicians

	Bright/dark?	When? (during/after)	Where? (toilet/TP)	How often?	How much?	Pain?	Other symptoms/signs?
Internal hemorrhoids	Bright	Either	Either	Intermittent	+/+++	+ to ++	Prolapse
External hemorrhoids	Either	After	TP	Periodic	+	+++	Lump
Fissure	Bright	After	Either	Intermittent	++	+++	Tag
Abscess	Either	After	TP	Periodic	+	++	Pus
Fistula	Bright	After	TP	Intermittent	+	0/+	Clear to purulent drainage
Pruritus ani	Bright	After	TP	Most	++	++	Itching
Radiation	Either	During	Toilet	Intermittent	+/+++	0/+	Mucous/urgency
Infection/Ulcer	Bright	After	TP	Periodic	+	+	Drainage?
Rectal prolapse	Bright	Either	Either	Intermittent	+/++	+	Mucous/prolapse
Tumor	Either	Rectal- During Anal- either	Either	Intermittent	+/++	0/+	Mucous/urgency
Diverticulosis/AVM	Either	During	Toilet	Periodic	+/+++	0	None

(*e.g.*, sexually transmitted proctitides, Clostridium difficile, etc.) or inflammation (ulcerative colitis, Crohn's colitis). Damage to the tissues from radiation or prior surgery can also cause inflamed rectal tissue, which is prone to hemorrhage. Seek out these possibilities with a careful history.

M. Colonoscopic findings

More proximal sources of bleeding include prolapse, bleeding diverticular disease, inflammatory bowel disease, arteriovenous malformation, neoplasia, and ischemia. These topics are covered in more detail in other chapters of this book. Overall, 33–42% of lower GI bleeding is due to diverticulosis. In 80% of patients, the bleeding will cease spontaneously. However, 5% of patients will have hemodynamically significant bleeding. Although 75% of diverticulosis is usually on the left, when diverticulosis bleeds, it can be from a right-sided source in 50–90% of cases. Risk factors for bleeding diverticulosis includes: low fiber diet, constipation, advanced age, NSAID and/or aspirin use.

Refer to Fig. 7.2

Severe Hematochezia Causing Hemodynamic Instability

N. Enteroscopy

Small bowel endoscopy, capsule endoscopy, enteroclysis, intraoperative endoscopy, and upper GI contrast studies are all ways to evaluate the bowel lumen. For evaluation of the colon, air contrast barium or gastrografin enema and CT colonography are ways to image the colonic lumen, but since they are not therapeutic, they are much less favored in the work up of lower GI bleeding. Elective exploration is usually used as a last resort in the patient who is not actively bleeding but who has had multiple bleeding episodes without having a source identified.

Contrast studies can find a Meckel's diverticulum. Meckel's is a true diverticulum located in the terminal ileum 45–90 cm from the ileocecal valve, which is a remnant of omphalomesenteric duct present in about 2% of the population. Of symptomatic diverticulae, 40% present as bleeding due to ulceration caused by heterotopic gastric mucosa. The treatment is resection.

O. Radionucleotide testing

Radionuclide scan can be done using technetium-99 m sulfur colloid or technetium-99 m-labeled autologous red cells. A bleeding rate of 0.1–0.5 ml/min can be demonstrated. The accuracy of these scans varies between 30–90%. With a positive scan it is reasonable to continue with angiography with the aim of therapeutically embolizing the area and abdicating the role of surgery. Another possible adjunct of the two modalities is also the most sensitive method to detect slow bleeding: injection of technetium through a selectively positioned angiography catheter.

P. Angiography

Mesenteric angiography can be useful if the bleeding rate is >0.5 ml/min, selective angiography may slow the bleeding lesion. The prerequisite for the positive angiography is active bleeding at the moment of the contrast injection. If a lesion is found during angiography, it may be amenable to embolization, thus making the both diagnostic and therapeutic. The embolization must be as peripheral as possible to prevent bowel wall necrosis. If successful, embolization may stop the bleeding. Even if unsuccessful, it will facilitate the location of the bleeding lesion to aid in preoperative planning.

Q. Surgery

In the patient with continued lower GI bleeding without an obvious source, it is advisable to proceed with a total abdominal

colectomy. The operation avoids the complication of continued postoperative bleeding after a lesser operation. However prior to blind colectomy, intraoperative pan-endoscopy with transillumination can be performed. Localization of a segmented source will allow segmental resection. If a total abdominal colectomy is performed, an anastomosis should generally be avoided. Alternatively, anastomosis with loop ileostomy may be acceptable.

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8 Anal Disease in the Neutropenic Patient

Margaux N. Mustian and Melanie S. Morris

Refer to Algorithm in Fig. 8.1

A. The prevalence of anal disease in oncology patients is reportedly 2–32%, with recent mortality rates ranging from 11–57% secondary to complications from perianal sepsis. Neutropenia is defined as fewer than 1000 cells/mm^3 granulocytes, while severe neutropenia is fewer than 500 cells/mm^3. Patients undergoing systemic chemotherapy with subsequent neutropenia lack the appropriate immune response necessary to overcome anorectal infections, which makes these infections significant and potentially lethal. Neutropenia can be a result of chemotherapy regimens, hematologic malignancies, HIV, long term corticosteroid use, or other systemic illnesses. Mortality rates due to perianal sepsis in this patient population are reportedly as high as 78%. The risk for sepsis has been strongly correlated with degree of neutropenia due to the role of neutrophils in mounting an inflammatory immune response and formation of pus. Likewise, count recovery has been associated with improved outcomes. Debate still exists, however, regarding the utility of the absolute neutrophil count in determining treatment plans. Historically, the absolute neutrophil count (ANC) has been used as a tool for determining the role of surgical intervention, but the utility of this lab value as a risk factor for surgical outcomes remains controversial. Additionally, the role for using colony-stimulating factors has been described in the literature as an adjunctive therapy to enhance patients' abilities to mount an immune response. In a retrospective analysis of 18 patients, Shaked et al. recommend awaiting count recovery to above 1000 cells/mm^3, prior to surgical intervention based on their retrospective analysis of patients with agranulocytosis. They found that attempts to drain inflammation for patients without purulence did not improve outcomes due to open wounds with evidence of persistent spread of infection. In contrast, based on data from 20 leukemic patients with perianal infections (14 with neutropenia), Buyukasik et al. found poor outcomes for patients with severe neutropenia who were medically managed, so they recommended surgical management for patients without neutrophil recoveries. Badgwell et al. retrospectively evaluated 100 cancer patients at MD Anderson with anorectal infections, of which 48 of whom had

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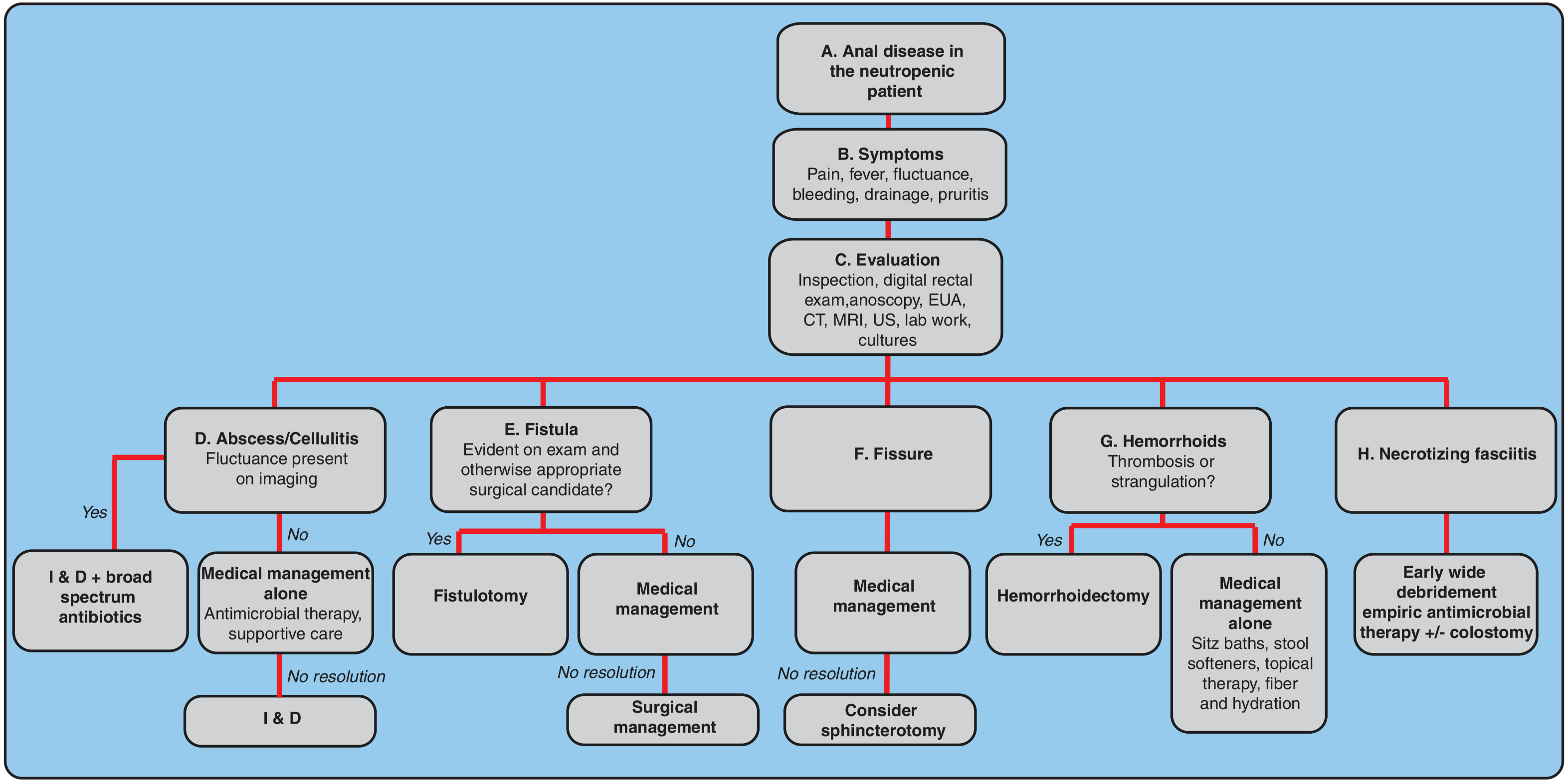

Fig. 8.1 Algorithm for anal disease in the neutropenic patient. *I & D* incision and drainage

ANC <1000 cells/ml. Sixty-seven percent of these patients were non-operatively treated. The authors stated that after accounting for other factors, neutropenia was not a significant determinant for the decision to pursue operative intervention. As neutropenic patients often have associated pancytopenia, thrombocytopenia also affects surgical decision-making. Concern for bleeding risk due to thrombocytopenia is also a common reason for delaying operative intervention.

Due to the complexity of this patient population, collaboration among multiple medical teams is necessary in order to provide care for the immunocompromised patient with anorectal disease, including surgeons, medical oncologists and infectious disease specialists for infectious etiologies. In many cases, conservative management with medical therapy is appropriate first line treatment in the absence of discrete perianal abscess with fluid collection or failure to respond to non-operative management. However, surgical intervention for anorectal disease may be necessary for select neutropenic patients with no prohibitively increased risk of morbidity or mortality given improvement in adjunctive medical therapy and critical care in a multidisciplinary approach.

B. When evaluating neutropenic patients with anorectal complaints, they may present with symptoms such as perianal tenderness or pain, fluctuance, fever, or bleeding. Similar to other populations, a wide array of physical symptoms may be used to describe their anorectal complaints. In order to further diagnose anorectal disease in the neutropenic patient, detailed history regarding symptomatology is key. Differential diagnoses should include anal fissure, fistula, hemorrhoids, abscesses, condyloma, and malignancy.

C. Work up of neutropenic patients with perianal symptoms begins as it would in the general patient population. Thorough history and physical exam direct the diagnosis, including digital rectal exam and anoscopy. Exams under anesthesia are often utilized due to patient intolerance of bedside exam secondary to pain. Further imaging may be necessary with computed tomography (CT) or magnetic resonance imaging (MRI), especially if there is a concern for abscess with no discrete evidence on physical exam. Larger abscesses can be visualized on CT scans but MRI may be beneficial for better evaluation of fistulous tracts or smaller fluid collections. The role for MRI is debated. Morcos et al. found that in their single institution, MRI results did not change clinical management and do not recommend routine use except for in the case of uncertain diagnosis. Ultrasonography can also be used to evaluate for fluid collections without radiation exposure.

D. Certainly, in the immunocompetent population, management for perianal abscesses necessitates an incision and drainage. However, in this unique patient population, the decision to proceed with an operation is more complicated. These patients may have an absence of classic signs of abscess formation such as purulent drainage or fluctuance. Instead, their main signs or symptoms may be perianal pain and fever. On exam, they may have areas of erythema or induration but again may lack any appreciable areas of fluctuance. As a result, a high index of suspicion must be maintained for any neutropenic patient who presents with fever and perianal pain. These symptoms usually arise when neutrophil counts nadir, around 1–2 weeks after cytotoxic chemotherapy. An exam under anesthesia is highly recommended in this population to evaluate for and exclude occult abscess. Blood and urine cultures should be obtained at the time of presentation to evaluate for other sources of infection, after which broad spectrum, empirical antimicrobial therapy with both gram positive and gram negative coverage should be initiated. If an abscess is identified on physical exam or during an exam under anesthesia, treatment with an incision and drainage should be performed. Surgical intervention should also be considered for those patients not responding to conservative medical therapy alone.

Imaging with CT or ultrasound may also be useful to identify fluid collections not appreciated on physical exam. Alternatively, needle aspiration at the bedside may also be utilized to determine treatment plan. A retrospective study from the National Cancer Institute in 2002 examined anorectal infections for patients undergoing chemotherapy found that over the course of 12 years over half the patients were treated with antimicrobial therapy alone, and 30/82 (37%) of patients required surgical intervention. This study also demonstrated the recent improvement in medical management and critical care, with no deaths attributed to anorectal infection during the study period (1984–1993), as compared to the previous decade at the same institution with mortality rate of 15.9%. As such, they advocated for selective surgical intervention for patients with discrete abscesses, progression of soft tissue infection or signs of necrosis.

E. Perianal fistulas in neutropenic patient are treated similarly to anorectal infections or abscesses. Many patients require an exam under anesthesia to confirm diagnosis. MRI may also be beneficial to identify fistulous tracts. Once the diagnosis is made, the decision for operative intervention is similar to the outlined evaluation for perianal abscesses. Conservative medical management should be attempted, with select patients undergoing surgical intervention. Antimicrobial therapy, including metronidazole is often recommended for these patients. In immunocompetent patients, a randomized controlled trial evaluating patients with fistula identified intraoperatively for perianal sepsis demonstrated lower recurrence rates (5%) for patients randomized to drainage plus fistula treatment compared to drainage alone (29%). The same principles can be applied to neutropenic patients. If they warrant surgical intervention based on exam or failure to respond to medical therapy and undergo incision and drainage of an abscess and are found to have fistulous disease, intervention for the fistula should also be performed.

F. Patients with anal fissures will typically describe pain as their chief complaint, with feelings as though they are "sitting on glass." These patients will not usually tolerate a digital rectal exam or anoscopy, but external examination will demonstrate small lesion or tear to the anoderm usually in the posterior midline. Neutropenic patients with fissures should be treated non-operatively with Sitz baths, pain control, stool softeners, high fiber diet and topical therapy. Surgical intervention is not recommended for this patient population as the potential risks outweigh the benefits.

However, in the neutropenic population, fissures may also occur in locations other than the posterior midline and with no response to medical therapy may require surgical intervention or biopsy of the atypical fissure. In a retrospective analysis of 151 leukemics with benign anorectal disease, Grewal et al. described a subgroup of 22 neutropenic patients with anal fissures, 15 of which were treated operatively with sphincterotomy. There was no difference in outcomes and mortality between their operative and non-operative groups, which led them to conclude that surgical intervention does not lead to excessively poor outcomes in selected patients when operative intervention is otherwise clinically indicated.

G. Patients with hemorrhoidal disease may present with varying complaints, which include bleeding, pain, perianal itching or identification of mass-like protrusion or edema. Physical exam, including digital rectal exam with anoscopy should be performed for further evaluation. As anorectal instrumentation during neutrophil nadir may lead to higher risk of perianal sepsis, most hemorrhoidal disease can be safely treated with medical management alone. Treatment regimen should include high fiber diet and supplementation with adequate hydration, Sitz baths, stool softeners, and topical medications. However, some patients may present with an acute hemorrhoidal crisis due to thrombosis of external hemorrhoids, or incarceration or swelling of

prolapsed internal hemorrhoids, which leads to severe pain and may cause bleeding or pressure necrosis of overlying skin. Surgery in the neutropenic patient is typically only recommended for patients with acute hemorrhoidal crises, and even for these patients count recovery is encouraged prior to surgical intervention. Data for surgical intervention for this patient population is exceptionally sparse. In the review of leukemia patients at MSKCC, 12 patients with hemorrhoidal disease were identified. Operative management was performed for two patients and one mortality was observed, while the non-operative group had no mortalities. Additionally, North et al. found that medical management alone for patients with symptomatic internal or external hemorrhoidal disease did not lead to increased risk of poor perioperative outcomes in their group of 30 patients from 1982–1994. While there are no established guidelines for this particular patient population, the general conclusions that can be drawn from small case series in the literature are that medical management does not lead to poorer outcomes. However, selected patients with strangulation or thrombosis may be safely managed safely with an operation if indicated or after failure of medical therapy.

H. Patients presenting with signs or symptoms of necrotizing infection should be managed with early initiation of broad spectrum antimicrobial therapy and early surgical intervention. Neutropenic patients are treated in same manner as their immunocompetent counterparts with early wide surgical debridement for necrotizing soft tissue infections. However, in the neutropenic patient, there is a much higher risk of mortality associated with this disease process. Therefore, a high index of suspicion is necessary for neutropenic patients with concern for necrotizing fasciitis and a low threshold for operative intervention. Once in the operating room, debriding down to healthy tissue during the initial operation is also critical. Additional operations to ensure thorough debridement of all necrotic tissue may be needed. Additionally, many patients will require diversion with an ostomy to enhance recovery.

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9 Evaluation and Perioperative: Anal Mass

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Refer to Algorithm in Fig. 9.1

A. Careful and detailed evaluation is warranted when working up a patient with concern for an anal mass. As with any thorough history details regarding onset, location of the mass, duration of symptoms, presence and characteristic of pain, aggravating or alleviating factors, associated symptoms, and prior episodes, should be obtained. Additionally, discussion pertaining to bowel habits, character of stool, constipation, diarrhea, pain with bowel movement, bleeding per rectum, anal discharge or leakage, fluctuation in size of mass, incontinence episodes, pruritus, difficulties with hygiene maintenance, or constitutional symptoms should be discussed. A detailed sexual history should be obtained regarding sexual orientation, practices of anoreceptive intercourse, prior history of sexually transmitted diseases, barrier contraceptive use, HIV status or other immunocompromised states. Social habits including smoking status and intravenous drug use should also be discussed. Personal or family history of inflammatory bowel disease, such as Crohn's disease or ulcerative colitis, and colorectal cancer should be elicited as well.

B. Much of the differential diagnosis may be generated from appearance and palpation of the anal mass on physical examination. The patient should be properly gowned and draped in a manner to preserve as much modesty as possible, as the examination may be anxiety provoking. Prone jackknife positioning is preferred for adequate exposure, but lateral decubitus may be an acceptable alternative. Once the patient is properly positioned in a well-lit room, careful visual inspection and palpation of the perianal and perineal region should be conducted. According to the algorithm in Fig. 9.1, a broad differential may be generated based on the presence or absence of pain at the site of the lesion. Further stratification may be obtained based on the following features: the presence of erythema, hematoma, ulceration, exophytic, or draining lesions.

C. Better characterization of the mass may occur with the aid of digital rectal examination. With the use of copious lubrication, the index finger of the dominant hand may be gently inserted into the anal canal. Circumferential evaluation should occur with particular attention to findings of tenderness, extension of an external mass, ulceration, internal fistulous openings, and internal hemorrhoids. If a mass is present, sphincter involvement, distance from the anorectal ring, firmness, and mobility of the lesion,

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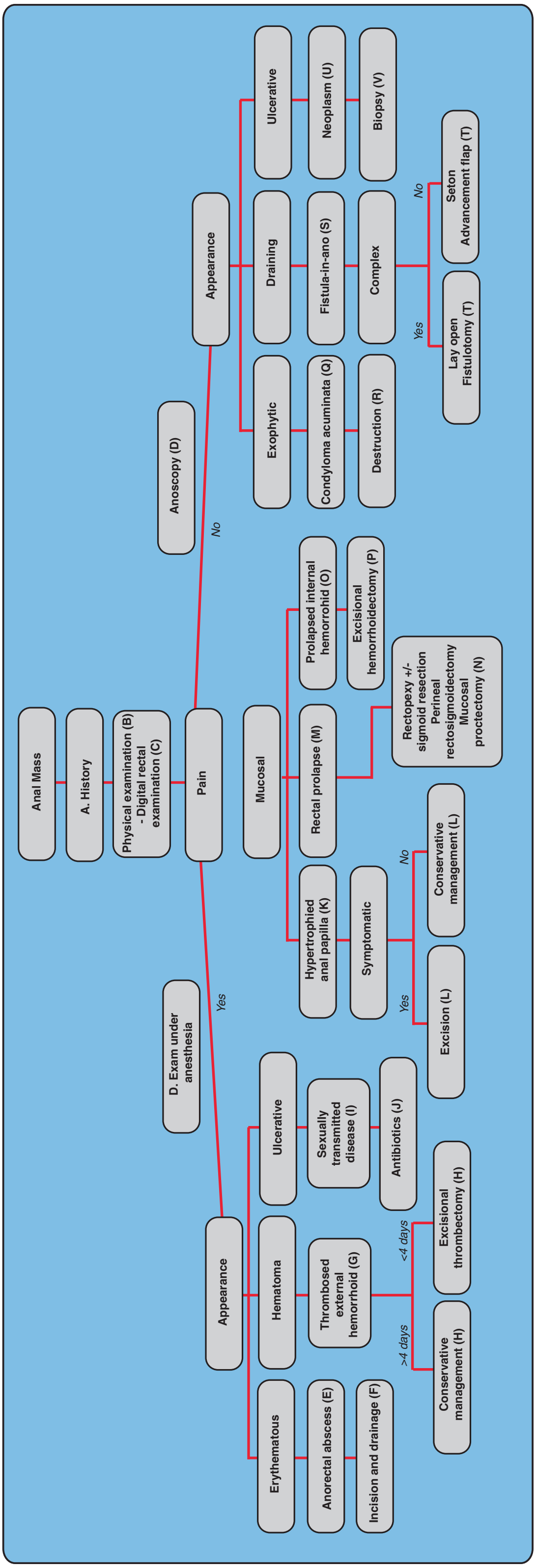

Fig. 9.1 Algorithm for evaluation and management of anal mass

should all be assessed. Evaluation of the sphincter complex may be performed by having the patient squeeze around a fully inserted finger. A gentle sweep above the anorectal ring is warranted for full characterization. Additionally, bi-digital rectal examination may provide beneficial when assessing the tract of a fistula-in-ano and potential sphincter complex involvement. To conduct this maneuver, an inserted index finger pushes outward against the anal mucosa while simultaneously utilizing the thumb to push the anal verge in an inward direction. If at any time unbearable pain is generated, the examination should be aborted and the patient should be scheduled for an anorectal examination under anesthesia.

D. If the patient has tolerated the digital rectal examination, further internal visualization should be conducted via anoscopy. A well lubricated anoscope is inserted into the anal canal. Circumferential evaluation of the canal should be conducted. This technique will help directly visualize the severity of internal hemorrhoid disease, mucosal abnormalities, ulcerations, internal fistulous openings, or internal lesions. If any concern for inflammatory bowel disease or rectal involvement, sigmoidoscopy or formal colonoscopy may be warranted.

E. An anorectal abscess can form an erythematous, painful, protuberant external anal mass. Abscess formation can occur in several distinct anatomical locations; including the supralevator, ischiorectal, intersphincteric, and perianal spaces. The most prevalent site for abscess formation is in the perianal space. Anatomically, numerous anal glands and ducts empty into anal crypts at the dentate line. Luminal or glandular obstruction due to a multitude of etiologies, such as, foreign body, trauma, prior surgical intervention, or malignancies, can result in accumulation of static mucous products resulting in a nidus for infection. Common clinical manifestations of a perianal abscess are pain, swelling, constitutional symptoms. Patients may report foul smelling, purulent drainage if the abscess has spontaneously drained prior to evaluation. When evaluating a patient with these complaints, a thorough history is warranted with careful attention to those areas previously outlined in the beginning of the chapter. Physical examination should encompass a careful external examination noting extent of the erythema and the central location of the abscess. If the abscess has not ruptured, palpation may elicit intense pain and fluctuance. It is important to note, that deep ischiorectal, intersphincteric and supralevator abscesses may not reveal external findings. A digital rectal examination may be attempted assessing for additional areas of internal fluctuance and/or presence of a fistula-in-ano.

F. The management of perianal or superficial ischiorectal abscesses is incision and drainage. Often times these may be drained under local anesthetic in the ambulatory setting. Larger and more complex abscesses should be drained under anesthesia in the operating room. If amenable to bedside drainage, the area of maximal tenderness, fluctuance or drainage should be identified. This region should then be circumferentially infiltrated with local anesthetic. A cruciate incision should be conducted over the center of the lesion. The corners of the incision should be cut free by scalpel or scissor to ensure adequate drainage. If present, loculations should be disrupted with gentle, blunt dissection via clamp or forceps. Copious irrigation should be utilized to ensure all purulent material has been removed. The wound site may be temporarily packed. With adequate drainage, antibiotic coverage is not necessary in the otherwise healthy individual. The wound site should be evaluated in follow up to ensure no evidence of recurrence has occurred.

G. A thrombosed external hemorrhoid may also present as an acute, painful external anal mass with associated hematoma. Hemorrhoids are normal anatomical cushions of vascular tissue located in the anal canal. Three main cushions exist in the left lateral, right anterolateral and right posterolateral regions of the anal canal.

External hemorrhoids are located in the distal aspects of the anal canal, are covered by anoderm, and have somatic innervation. Classically, external hemorrhoid thrombosis presents as acute perianal pain with a firm mass along the anal verge. A bluish/purple discoloration of the mass may be reported by the more curious patient. Physical examination should be conducted in the prone jackknife or left lateral decubitus positions. Visual inspection and digital rectal examination should be performed. With appropriate pain relief, anoscopy should be performed in order to exclude a strangulated, prolapsed internal hemorrhoid or a large, edematous, perianal skin tag associated with Crohn's disease, as management would differ.

H. Treatment for a thrombosed external hemorrhoid is contingent upon timing of presentation. The natural history of a thrombosed external hemorrhoid is severe, progressive pain until 48–72 h. After this time frame, pain slowly improves with the start of thrombus resorption or rupture through the overlying necrotic skin. Therefore, if a patient presents within 4 days of onset, excisional thrombectomy is warranted. In the office, the patient is placed in the prone jackknife position. A local anesthetic field block is applied to region surrounding the thrombosed external hemorrhoid. An elliptical incision is then conducted encompassing the necrotic skin overlying the thrombus. The thrombus should then be fully expressed or removed with forceps. Hemostasis should be obtained via direct pressure or other hemostatic agents like silver nitrate applicators. The skin edges are left open for adequate drainage. Oral analgesics and stool softeners may be necessary after excision. Sitz baths should be conducted at least three to four times per day, and after bowel movements. Simple incision and drainage should be avoided in this situation, as it will be inadequate. If the patient presents outside of the first 4 days of symptoms, conservative therapy should be offered. This includes analgesia, stool softeners, Sitz baths as described above.

I. Several sexually transmitted diseases (STD) may present as a painful, ulcerative internal and/or external anal mass. Typically, this infection occurs through the process of anoreceptive intercourse, although may be an extension of active genital/perineal disease. Damage received to the mucosal lining during anoreceptive intercourse allows for the transmission of pathogens. Patients with ulcerative STD's may present with fever, chills, lethargy, general malaise, rectal/anal pain, pruritus, discharge, and tender lymphadenopathy. When assessing these complaints, it is pertinent to obtain a very detailed sexual history as outlined earlier in the chapter. On physical examination, a thorough examination of the inguinal lymph nodes, genitalia, perineum and perianal region should be conducted with notation of lymphadenopathy, lesions or ulcerations. Digital rectal examination, anoscopy and/or sigmoidoscopy should be performed to evaluate the internal mucosa of the anal canal and the rectum for signs of proctitis.

J. Common organisms and viral infections precipitating the development of ulcerative lesions include: Lymphogranuloma venereum strains of *Chlamydia trachomatis*, *Hemophilus ducreyi, Treponema pallidum* and herpes simplex virus. Often these organisms may be difficult to identify with routine culture. Diagnosis is typically generated by detailed history, physical examination and exclusion of other infections. In the case of Syphilis, caused by *Treponema pallidum*, diagnosis is made via either dark-field microscopy or a series of serologic testing including rapid plasma regain, Venereal Disease Research Laboratory, and the fluorescent treponemal antibody absorption test. Antibiotic therapy is the mainstay of treatment for these ulcerative STD's. Unfortunately, herpes simplex virus may cause recurrent outbreaks due to latency of the virus. Treatment is based on symptomatic relief during an outbreak, oral antiviral therapy, and suppressive therapy targeted at recurrence.

K. Hypertrophied anal papillae may present as a mucosal appearing external anal mass. Often, development may be associated with a chronic anal fissure; however, idiopathic enlargement may occur as well. Clinically, patients may report a precipitating acute anal fissure occurring several weeks prior. Inability to heal this fissure may result in a chronic state. This continued inflammation and irritation may lead to hypertrophy and prolapse of the adjacent internal anal papillae. Additional complaints of poor perianal hygiene, pruritus, and mucous discharge may be noted. On physical examination, careful retraction of the buttocks will reveal a bulging mucosal mass. An anal skin tag, often referred to as a sentinel pile, may also be present externally. The presence or absence of a chronic anal fissure should be noted. Digital rectal examination and anoscopy may be attempted in the setting of a chronic fissure, but should be performed judiciously in the office if an acute anal fissure is present. If idiopathic hypertrophy, a biopsy may be warranted if irregularities are identified.

L. Conservative therapy is the mainstay of treatment for benign hypertrophied anal papillae. If associated with a chronic anal fissure, treatment should also address the underlying fissure. Simple mucosal excision may be warranted if proving symptomatic or if suspicious for malignancy.

M. Full thickness or mucosal rectal prolapse may also generate a painless, bulging, mucosal anal mass. Careful assessment of bowel habits, constipation, incontinence, frequency of prolapse, and obstetrical history in women should be obtained. Several anatomic factors may cause full thickness rectal prolapse including redundancy of the rectum and weakness of the pelvic floor musculature. Presenting complaints typically revolve around a protruding, painless mass. Other associated features may include rectal fullness, sensation of pressure, incontinence, excessive straining, and feelings of incomplete defecation. On physical examination, the rectum may already be prolapsed. If not, the patient may be placed on a toilet and made to strain as if having a bowel movement. This should generate prolapse. Full thickness rectal prolapse is identified by concentric folds of tissue and redundancy to the rectal wall. Rectal mucosal prolapse has a more radial appearance to the tissue folds. Once the prolapsed is reduced, digital rectal examination should be performed to assess rectal tone and sphincter strength. In rare instances, neoplasia can be the cause for prolapse. Endoscopic evaluation may be warranted to evaluate the rectum and distal colon. Any suspicious lesions should be biopsied to rule out malignancy.

N. Operative treatment for full thickness rectal prolapse depends on overall surgical risk. For low risk individuals, a transabdominal rectopexy with or without resection of the sigmoid is preferred. A high risk patient might be better served by a perineal proctosigmoidectomy or mucosal proctectomy.

O. Prolapsed internal hemorrhoids may present as a mucosal appearing external anal mass. Internal hemorrhoids are located proximal to the dentate line, covered by columnar epithelium, and have visceral innervation. Development of internal hemorrhoids is caused by venous outflow obstruction. This progresses to congestion, swelling and prolapse of the effected vascular cushion. Common symptoms include hematochezia with defecation, mucous discharge, sensation of inadequate rectal emptying, and inability to maintain perianal hygiene. Please refer to section on thrombosed external hemorrhoid for specific physical examination strategies and findings.

P. Common treatment options for internal hemorrhoids depend on the severity of disease. Grade 1 (no prolapse) and Grade 2 (spontaneously reducing) may benefit from conservative medical management and/or rubber band ligation, sclerotherapy, or infrared coagulation. It is acceptable for less advanced Grade 3 (manually reducible) internal hemorrhoids to undergo conservative management illustrated above. However, more advanced Grade 3 and Grade 4 (irreducible)

internal hemorrhoids should undergo excisional hemorrhoidectomy.

Q. Human papilloma virus has been identified to cause the development of exophytic perianal and anal condyloma acuminata. Roughly 40 subtypes have been shown to play a causative role in anogenital infection. Of these, HPV types 6, 11 are the most common subtypes to generate benign anogenital warts. Types 16, 18, 31, 33, and 35 can generate exophytic anogenital lesions, but also confer a greater risk of dysplasia and carcinoma. Transmission occurs via sexual intercourse with a partner manifesting active disease, subclinical, or asymptomatic infection. Development of anal warts can occur in the absence of anoreceptive intercourse. Bleeding and pruritus may be associated complaints. Their appearance typically resembles pink, "cauliflower-like" exophytic lesions. Diagnosis is based on clinical evaluation. A thorough internal examination via anoscopy is crucial to identify additional lesions in the anal canal.

R. Treatment consists of destruction of the lesions. Common techniques for mild disease include topical applications with imiquimod or podophyllin, excision, or fulguration with electrocauterization, or laser therapy. Minor disease may be eradicated in the office setting under local anesthetic. More extensive disease is best dealt with in the operating room under intravenous sedation or general anesthesia. Regardless of the method for obliteration, continued surveillance is crucial as recurrent lesions and development of anal intraepithelial dysplasia may occur.

S. A draining external anal mass may result from development of a fistula-in-ano. A preceding anorectal abscess can result in the epithelialization of an aberrant tract with extension to the anus or rectum. Fistula-in-ano often manifest with an internal opening present in the anal canal or rectum, as well as an external opening on the perineum. There are several different classifications of fistula-in-ano including; intersphincteric, trans-sphincteric, suprasphincteric, and extrasphincteric. The specific details of each type of fistula-in-ano will not be discussed in this chapter. Common clinical manifestations include spontaneous drainage, pain with defecation, bleeding, and perineal pressure. Identification of the external opening(s) on physical examination may be evidenced by the presence of purulent drainage, fluctuance or granulation tissue. Digital rectal examination should evaluate for the presence of an internal opening. Positive findings include a raised, nodular region or a small depression along the normal mucosa. However, identification of the internal opening may be difficult. Goodsall's rule may provide a useful predictor for the expected location of the internal opening. While examining the perineum, a transverse line through the center of the anus marks the posterior and anterior perineum. Posterior to this line, the fistula tract typically travels curvilinear, with the internal opening located in the posterior midline. Anterior to this line, the tract typically travels in a linear fashion, entering at the closest anal crypt. Temptation to probe the fistula tract should be avoided in the office setting. Imaging modalities, such as, fistulography, anorectal ultrasonography, or MRI, have been described and should be restricted to more complex or recurrent disease.

T. The goal of treatment is to identify and successfully remove the fistula tract, while circumventing damage to the sphincter complex. Based on the location of the fistula, different surgical treatment options exist. The lay-open fistulotomy technique has been described for the treatment of low trans-sphincteric or uncomplicated intersphincteric fistulas. For complex fistulas denoted by potential involvement of the sphincter complex, recurrent disease, IBD or an anterior location in a female patient, the placement of a seton or endorectal advancement flap may be recommended.

U. Although relatively uncommon, anal cancer can present as a painless, ulcerative anal or perianal mass. These represent roughly only 2.6% of all digestive system malignancies.

Brief review of the anal canal and anal margin will be imperative in understanding the embryological origin of malignancies that arise in this region. Proximally, the rectum transitions to the surgical anal canal at the anorectal ring. This ring denotes the most superior aspect of the sphincter complex. The canal extends past the dentate line for 1–2 cm until it reaches the distal border at the intersphincteric groove. From this point distally, the anal margin extends roughly 5 cm in a circular fashion encompassing the perianal skin. At the proximal border, the mucosa is comprised of columnar epithelium. At the level of the dentate line, a transitional zone of epithelium develops. Columnar epithelium begins to transition to squamous epithelium, which then constitutes the distal aspect of the anal canal and margin. Although full description and treatment of the numerous anal malignancies will not be covered in this chapter, they will be listed based on location. Malignancies arising in the anal canal are typically squamous cell, adenocarcinoma, melanoma, or sarcoma. Those of the anal margin consist of squamous cell, basal cell, verrucous, Kaposi's sarcoma, and lymphoma. Often patients will present with symptoms of bleeding, anal pain, pressure, presence of ulceration or a bulging external mass. When evaluating these complaints, a detailed history is warranted. A full review may be found in the beginning of the chapter, but particular attention should be paid to growth in size of the lesion, episodes of incontinence, HPV status, anoreceptive intercourse, immunodeficiency disorders, and smoking status. Physical examination should include external visual inspection with documentation of vertical and horizontal diameters of the lesion, location, extension into the anal canal, irregularity, pigmentation, firmness, presence of ulceration. Digital rectal examination and anoscopy should be conducted circumferentially to evaluate for the presence of internal lesions. If identified additional information regarding mobility of the lesion should be noted. Careful assessment of sphincter involvement should be documented.

V. All suspicious lesions should be biopsied. This may be conducted in the prone jackknife position. Local anesthetic should be applied surrounding the area for biopsy. The area should be biopsied at the junction of lesion and normal appearing tissue. The specimen should be sent for prompt histopathological analysis. Additional use of imaging modalities may be warranted to further characterize the lesion. Endoanal/endorectal ultrasonography, computed tomography, and pelvic magnetic resonance imaging will provide valuable insight into extent of the malignancy, sphincter involvement, lymphatic involvement, depth of invasion, and potential metastatic spread. Please refer to the section covering anal carcinoma for further treatment details.

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Part II

Anal Conditions

Check for updates

10 Anal Conditions: Anal Fissure/ Recurrent Anal Fissure

Alexandra Elias and Ron G. Landmann

Refer to Algorithm in Fig. 10.1

A. An anal fissure has a pathognomonic presentation, characterized by pain during defecation (passing glass, knives, razor blades, hot pokers, or barbed wire), post-defecatory pain (spasms or clenching lasting 20 min to 3 h), fear of defecation, and rectal bleeding (streaks of blood or drops on toilet paper).

B. Because of the pathognomonic presentation of an anal fissure, a thorough history focusing on symptoms, dietary habits (i.e. fiber content, fiber supplementation, and hydration), and details of defecation (e.g. presence of constipation or diarrhea, avoidance of defecation, caliber of bowel movements) is the most important tool for diagnosis. A confirmatory non-invasive physical examination should be performed to exclude other diagnoses. Perform gentle gluteal spread with mild anal canal effacement, and visually inspect for sentinel tag and/or break in anoderm revealing internal anal sphincter muscle fibers, being sure to note the location to determine whether the fissure is typical or atypical (Fig. 10.2). A typical fissure will be located in the midline, usually posteriorly (90%, but can also be located anteriorly), and will have sharply demarcated edges. An atypical fissure will be located laterally and may be painless, deep, and/or wet-appearing with weeping edges. Pruritus ani, which presents as very superficial excoriated fissures, should also be excluded.

C. Laboratory evaluation is not indicated for typical anal fissures. For atypical anal fissures, biopsy or culture may be indicated to evaluate for an alternative suspected disease process (e.g. sexually transmitted infection (STI), Crohn's disease, or cancer). *Please refer to chapter 23 for additional information*

D. Endoscopic evaluation is not indicated solely for typical acute anal fissures. For refractory disease, careful internal examination with anoscopy and/or flexible sigmoidoscopy is warranted to exclude other pathology. In the setting of chronic diarrhea or bloody bowel movements, colonoscopic evaluation for colitides should be considered. Patients who require endoscopy for routine colorectal cancer screening or surveillance guidance—apart from the fissure—should undergo colonoscopic evaluation as indicated.

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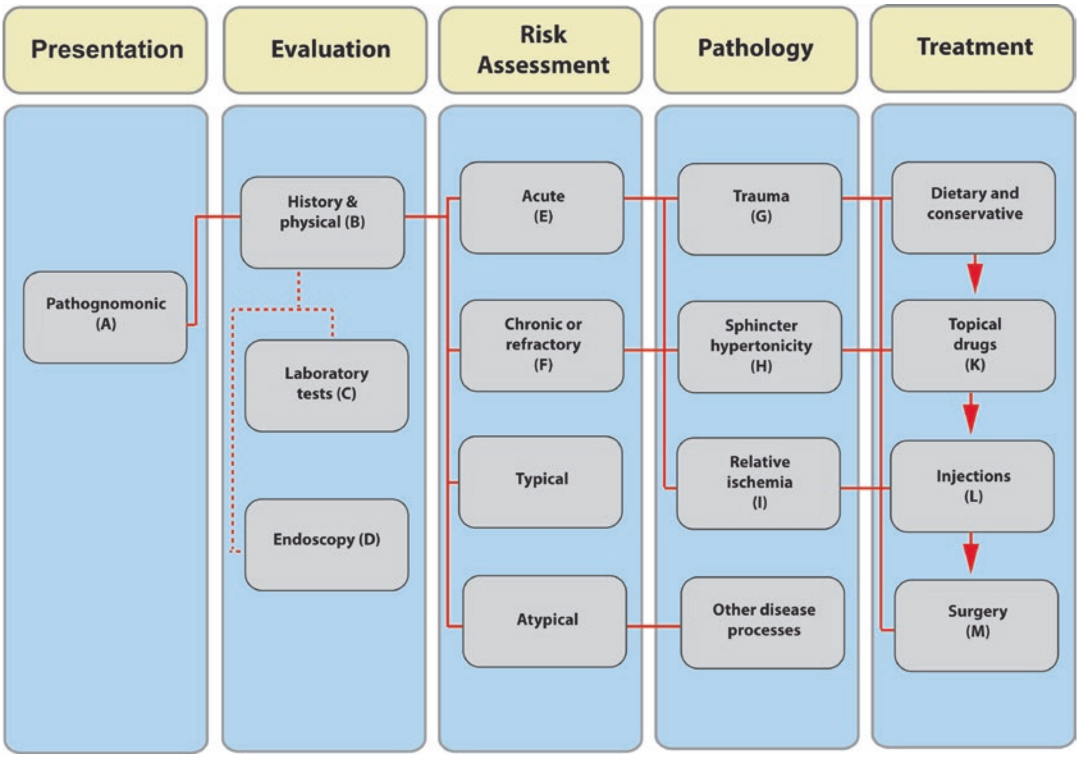

Fig. 10.1 Algorithm for anal fissure and recurrent anal fissure

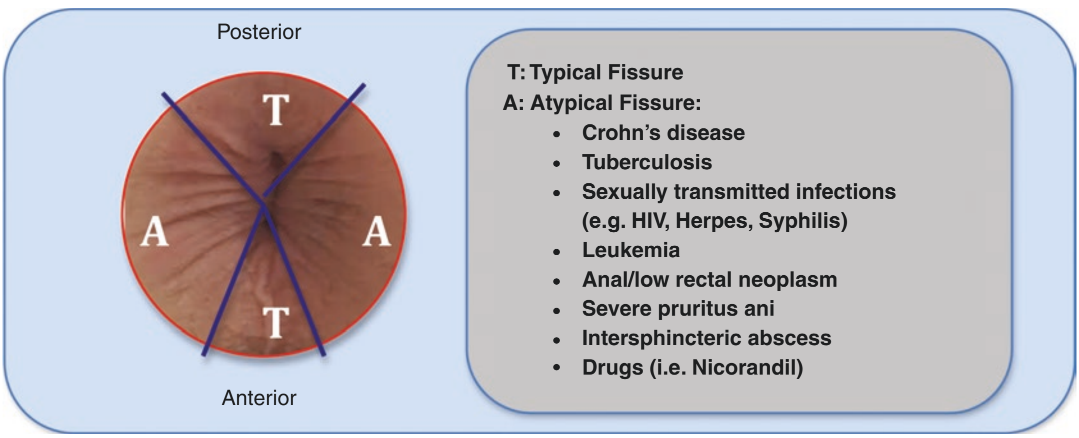

Fig. 10.2 Fissure type by location

E. An acute fissure is defined as a fissure that has been present for less than 6 weeks. They typically appear as superficial tears and lack the rolled edges, visible internal sphincter fibers and associated papillae and tags demonstrated with chronicity. The majority of acute typical anal fissures will respond to conservative management, which should be utilized as first line therapy (**refer to section L in algorithm**).

F. A chronic anal fissure is defined as a fissure that has been present for longer than 6 weeks. A 2012 Cochrane review demonstrated only one-third of patients with chronic fissures healed without medical or surgical interven-

tion. Medical therapy was effective for nearly half of patients; however, late recurrences were common (50%). Surgery may be necessary for chronic fissures refractory to medical therapies (**refer to section M in algorithm**).

G. Trauma from large, hard stool or anal penetration may lead to the onset of a fissure. The anorectal angle puts the posterior midline anoderm under the highest tensile stress, which may explain the frequency of fissuring in this location.

H. Manometry has revealed elevated internal sphincter pressures in patients with fissures. While some experts believe sphincter hypertonicity contributes to the formation of a fissure by aggravating the pre-existing relative ischemia, others argue sphincter hypertonicity is triggered in response to a fissure. Both topical and injectable medical therapies target sphincter hypertonicity and local tissue blood flow and perfusion (**refer to sections K and L in algorithm**).

I. Arteriography and laser Doppler flowmetry have demonstrated relative ischemia of the posterior midline anal canal.

J. The goals of treatment are to resolve pain, heal the fissure, maintain continence, and minimize recurrence. A 2012 Cochrane Review recommended conservative management with long-term dietary modifications as first line therapy. Ideally, the patient should have soft, well-formed, easily passable bowel movements. To this end, we recommend a high fiber diet (i.e. fresh fruit, vegetables, bran, whole grains) with additional fiber supplements (e.g. psyllium, Metamucil®, Konsyl, Benefiber®) and adequate hydration (i.e. 8–10 glasses of water daily with avoidance of caffeine and alcohol.). A goal of 20–30 g of soluble fiber is recommended. Stool softeners may be used short-term during the acute convalescence. Please refer to our treatment scheme (Fig. 10.3) and summary of treatment comparison trials (Table 10.1).

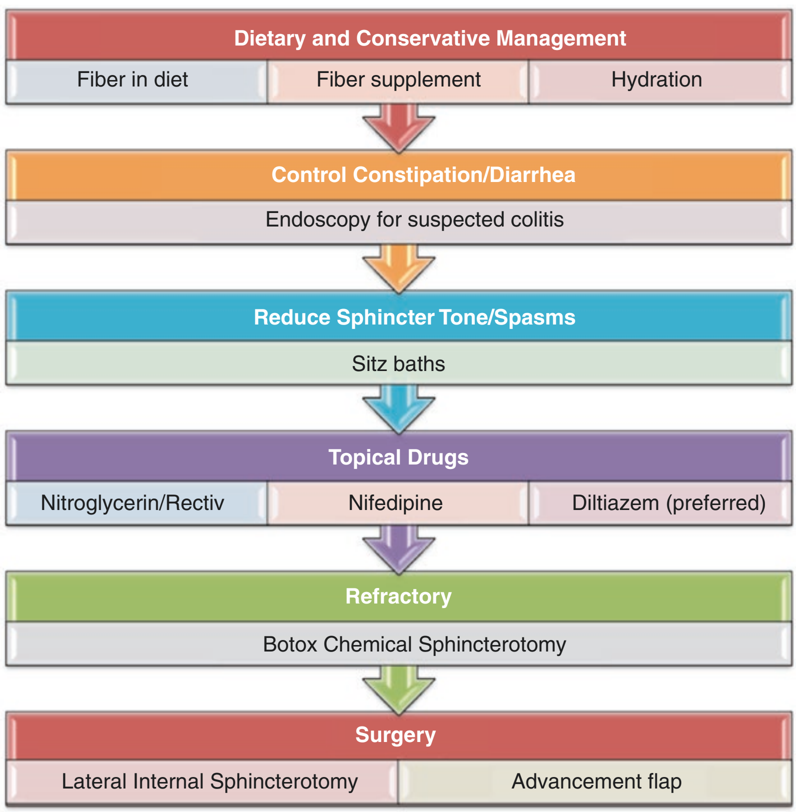

Fig. 10.3 Treatment scheme

Table 10.1 Treatment comparison trials

Comparison trials	Superior
NTG vs Placebo • Non-healing (OR 0.35) • Headache (OR 4.5)	NTG
NTG vs CCB (Diltiazem) • Non-healing (OR 0.88) • Adverse effects (OR 3.57) • Headache (OR 6.9)	CCB
NTG vs Sphincterotomy (LIS) • Non-healing (OR 7.49) • Incontinence (OR 0.51) • Headache (OR 29)	LIS
Diltiazem (CCB) vs Placebo • Non-healing (OR 0.1) • Adverse effects (OR 3.57) • Headache (OR 6.9)	CCB
CCB vs Sphincterotomy • Non-healing (OR 60) • Incontinence (OR 0.1) • Headache (OR 13)	LIS
Botox vs Placebo • NON-healing (OR 0.29) • Adverse effects (OR 1)	Botox
Botox vs Sphincterotomy (LIS) • NON-healing (OR 7.2) • Incontinence (OR 0.11)	LIS
Botox vs Botox + NTG • NON-healing (OR 2.4) • Incontinence (OR 0.3)	Botox + NTG
Any surgery vs Medical Therapy • NON-healing (OR 0.11)	Surgery

K. Topical options include compounded nitrates/nitroglycerin (NTG), such as Rectiv® (Aptalis Pharma US, 0.4% topical nitroglycerin), and calcium channel blockers (CCB), such as nifedipine or diltiazem 2%. A 2012 Cochrane review demonstrated NTG to be marginally superior to placebo, with the principle side effect of headaches (30%). We recommend use of diltiazem, as it is both more effective and more tolerable than NTG and nifedipine (Table 10.1). Generally, combinations with lidocaine are not necessary. Instruct the patient to apply a pea-to-toothpaste sized amount with a gloved finger to, but not inside, the anus four to six times daily for 6 weeks. Re-evaluate in 6 weeks, and allow for continued healing if progressing appropriately.

L. Botox® (onabotulinumtoxinA, Allergan, Inc) injections can be used to temporarily paralyze the internal anal sphincter by preventing release of acetylcholine from the presynaptic nerve terminals. Muscles begin to relax after several days, and the effect lasts up to 4 months. In conjunction with CCB, this regimen has demonstrated excellent and durable healing rates. While studies have shown botox injections to be less efficacious than surgery, studies have also demonstrated fewer side effects and lower incidence of incontinence to stool (10–18% temporary incontinence to flatus) (Table 10.1). There is currently no standardized dosage or technique. A recent meta-analysis concluded lower doses may have lower rates of recurrence and incontinence, however, it was limited by weaknesses in the underlying evidence. We recommend choosing one side and injecting 100 u/0.5 cc NS into the internal sphincter/intersphincteric groove with a tuberculin syringe.

M. Surgery may be necessary for refractory fissures that fail medical management. Surgery should not be used for children or acute anal fissure. The most significant risk of surgery is incontinence (9.8%) (Table 10.1). However, with specialized experience, this rate should be markedly less than 1–2%. For patients with anal hypertonicity, lateral internal sphincterotomy (LIS) is recommended, while a cutaneous advancement flap is recommended for patients with normal tonicity or a hypotonic anus. A combined approach may also be considered, as limited data shows the addition of an anocutaneous flap to botox injection or LIS may help decrease post-operative pain and expedite recovery. Sphincterotomy can be performed in an open fashion (our preference) or closed fashion. Generally the extent of internal sphincterotomy should be tailored to the length of the fissure or entire internal sphincter if a redo procedure is required. A tailored approach yields equivalent healing with a lower risk of incontinence compared to a traditional

approach that extends to the dentate line. An alternative treatment option may be percutaneous posterior tibial nerve stimulation, which has shown promising results in a few small trials. More research, however, is needed, as sham stimulation (placebo) had equivalent effects.

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11 Anal Conditions: Anal Stenosis and Stricture

Shafik M. Sidani and Maher A. Abbas

Refer to Algorithm in Fig. 11.1

A. Anal stenosis or stricture is a narrowing of the anal canal, and can be a true anatomic stricture or a functional stenosis secondary to sphincter hypertonicity. A true anatomic anal stenosis results from the loss of pliability and elasticity of the anoderm which is replaced by noncompliant fibrosis and scarring.

B. Anatomic anal stenosis can be congenital or acquired. Congenital causes include conditions such as anorectal malformations and Hirschsprung's disease. Overzealous hemorrhoidectomy resulting in extensive loss of anoderm is one of the most common acquired etiologies. Other acquired causes include extensive excision or fulguration of anorectal lesions or tumors, stapled hemorrhoidectomy, low anastomoses such as coloanal and ileoanal anastomosis, trauma, inflammatory bowel disease (IBD) particularly Crohn's Disease, radiation therapy, chronic anorectal suppurative disease, chronic diarrhea, chronic laxative use, and venereal disease.

C. Up to 88% of anal stenosis cases can be caused by hemorrhoidectomy, although only 1.5–4% of hemorrhoidectomies are complicated by a stricture. Classically, this complication, in association with mucosal ectropion, was seen more often after inappropriate modifications of the Whitehead Hemorrhoidectomy. Sphincter damage and fibrosis may further worsen the stenosis. The prevention of post-hemorrhoidectomy anal stenosis centers on avoidance of sphincter damage and the preservation of anodermal and distal rectal mucosal bridges. If this is not possible, one must either compromise on the amount of tissue excised, or perform a primary anoplasty at the time of hemorrhoidectomy. The former option is preferable. These considerations are particularly important in the setting of an acute hemorrhoidal crisis. As a guide, one must be able to introduce a medium Hill-Ferguson anal retractor at the completion of the procedure to minimize the risk of stenosis.

D. Patients with anal stenosis present most commonly with difficulty evacuating, constipation, painful bowel movements, bleeding, and narrow stool caliber. Fecal impaction may result in overflow incontinence and diarrhea. Concomitant mucosal ectropion may cause seepage or wetness. Frequently, patients rely on stool softeners, laxatives,

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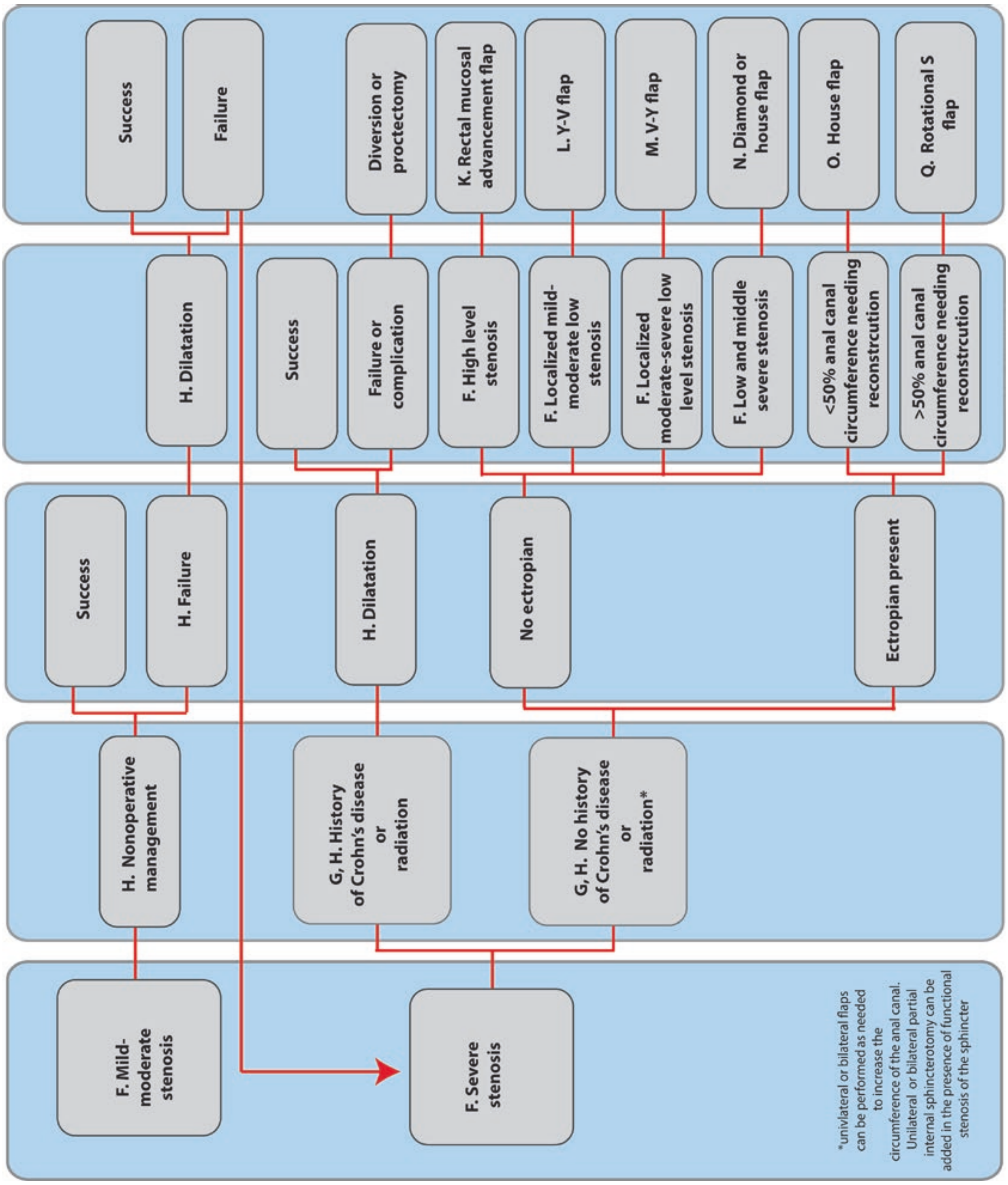

Fig. 11.1 Management algorithm for anal stenosis and stricture

suppositories, enemas, or even digital assistance to facilitate evacuation. Symptomatology and degree of stenosis on exam may not correlate, and management strategy is generally based on the former. This is particularly relevant in the setting of Crohn's Disease where patients may remain asymptomatic due to loose stools. A thorough history must be obtained to determine the etiology of the stenosis.

E. Inspection and digital examination easily reveal the condition. Narrowing of the anus, scarring, and fissuring with discomfort during distraction of the buttocks can be noted. An involutional stricture secondary to chronic laxative abuse, particularly mineral oil, appears as a delicate, smooth, tight anal canal classically referred to as "paraffin anus". Mucosal ectropion appears as moist mucosa extending beyond the anal verge. An anal fissure may result in functional stenosis. Frequently, examination is not possible due to patient discomfort and an exam under anesthesia is warranted. This allows for distinguishing between functional and anatomic stenosis. A functional stenosis will diminish with anesthesia whereas anatomic stenoses will persist despite anesthesia due to fibrosis of the anal canal. The severity, level, and extent of the stenosis can be determined. Cultures and/or biopsies can be obtained as indicated should one suspect venereal disease, Crohn's Disease, or neoplasia. If possible, endoscopic evaluation of the colon and rectum can be considered should there be concern for Crohn's Disease. Preoperative anorectal physiology testing is unlikely to be tolerated, and is unlikely to affect management.

F. Classification of anal stenosis is based on the level and degree of stenosis (Table 11.1). Furthermore, it can be circumferential, diffuse, or localized in the anal canal. Regarding severity, a stenosis is mild if it admits a well-lubricated index finger or medium Hill-Ferguson retractor, moderate if forceful dilatation is required to insert an index finger or medium Hill-Ferguson retractor, and severe if it does not admit the little finger or a small Hill-Ferguson retractor without forceful dilatation. The level of stenosis is described in relation to the dentate line. Low stenosis involves the anal canal more than 0.5 cm distal to the dentate line. Mid-level stenosis occurs within 0.5 cm distal or proximal to the dentate line. High stenosis extends more than 0.5 cm superior to the dentate line. These criteria, along with the specific etiology, determine the management strategy for an individual patient.

Table 11.1 Classification of anal stenosis

Severity	
Mild:	Tight anal canal that admits a well-lubricated index finger or medium Hill-Ferguson retractor
Moderate:	Forceful dilatation required to admit a well-lubricated index finger or medium Hill-Ferguson retractor
Severe:	Little finger or small Hill-Ferguson retractor not admitted without forceful dilatation
Level	
Low:	At least 0.5 cm distal to dentate line
Middle:	Within 0.5 cm distal or proximal to dentate line
High:	At least 0.5 cm proximal to dentate line

G. Chronic transmural inflammation or perianal fistulizing disease secondary to Crohn's Disease may ultimately lead to anal stenosis. These strictures can vary in length and involvement of the anus and rectum, and commonly may lead to diversion with or without proctectomy. Biopsies should be considered due to the risk of adenocarcinoma in long-standing Crohn's Disease.

H. Management depends on symptomatology and etiology, as well as the severity, level, extent, and localization of the stenosis (Fig. 11.1). Asymptomatic patients usually do not require treatment. Mild to moderate symptomatic stenoses are initially conservatively treated with stool softeners and bulking agents in an attempt to naturally and gradually dilate the anal canal by regular passage of stool. If conservative measures fail, dilatation can be considered. Initial dilatation frequently requires anesthesia, after which regular daily dilatation by the patient using

Fig. 11.2 (**a**) Hegar dilators (*Courtesy of Dr. Mustafa Sidani)*; (**b**) Plastic dilator used by the patient

plastic or metal dilators can be performed. Dilatation under anesthesia is performed gradually using a variety of well-lubricated dilators (Fig. 11.2) or with the finger. It is the authors' preference to dilate digitally as this approach allows a more controlled dilatation with less risk of proximal injury. After initial dilatation, patients are followed up frequently to ensure patient compliance and patency by digital exam. Infrequent follow-up after initial dilatation under anesthesia may require repeat dilatation under anesthesia should the stenosis recur. Stenoses secondary to Crohn's Disease or radiation therapy are managed using this approach due to the risk of poor wound healing after more complex surgical options. Poor surrounding tissue health is unlikely to allow for successful anoplasty in these 2 groups of patients. Good results can be expected using this approach; however it carries the risk of incontinence, as well as sphincter damage and fibrosis with progressive stenosis. Concomitant proctitis secondary to Crohn's Disease should be medically treated when possible prior to dilatation of anal stenosis to prevent infectious complications.

I. Moderate to severe anal stenosis that fails nonoperative management, can be tackled by several options. Most options involve incision or excision to release the nonpliable fibrotic scarring in the anal canal and replacement with a mobilized flap of compliant tissue from the anal skin or rectal mucosa. Adjacent tissue flaps are categorized as advancement (sliding), island, or rotational flaps. Advancement flaps utilize rectal mucosa proximal to the stenosis or anal skin distally. Tissue is mobilized while maintaining vascular and tissue continuity with the original surrounding tissue, and advanced into the anal canal. Vascular supply is derived from submucosal or subdermal plexuses. Examples include the rectal mucosal advancement flaps and Y-V anodermal flap. Island flaps which include U-shaped, rectangular, diamond, and house flap are completely disconnected from the surrounding tissue and derive their vascular supply from the underlying subcutaneous tissue. Critical to the success of island flaps is to include the subcutaneous tissue and avoid undermining of the flap to preserve the blood supply. Rotational flaps such as the S flap are full thickness and maintain continuity with the surrounding tissue to be rotated into the anal canal. Blood supply is based on both subcutaneous and subdermal vasculature. All types of flaps can be performed unilaterally or bilaterally (usually

right and left lateral positions) depending on the amount of tissue required to reconstruct the anal canal. The width of a single flap should not exceed 25% of the anal canal circumference. If more tissue is required, bilateral flaps should be performed. If scarring or ectropion is localized to a certain position in the anal canal, the flap is constructed in that specific position. Flap choice depends on surgeon familiarity with specific techniques and the level, extent, length, and severity of the stenosis, as well as the presence or absence of an ectropion (Table 11.2). Simple stricture release alone is unlikely to provide lasting symptomatic relief and is not recommended as the stricture is likely to reform without the interposition of healthy tissue. Unilateral or bilateral partial internal sphincterotomy can be performed additionally if there is an element of functional stenosis or sphincter fibrosis.

J. Preoperatively, patients are instructed to evacuate the rectum with an enema. Complete mechanical bowel prep is required for more extensive procedures such as bilateral house or S-flaps. Procedures are performed in the ambulatory setting under total intravenous anesthesia with local anesthesia, spinal anesthesia, or general anesthesia depending on the procedure, patient's preference, and body habitus. The patient is positioned in prone jack-knife with the buttocks taped apart. The tape may be released during the procedure to allow advancement of the flap. Intravenous antibiotics are administered preoperatively.

K. Rectal mucosal advancement flap (Fig. 11.3a): Considered a modification of Martin's anoplasty, this procedure is appropriate for mid or high level stenosis. The stricture is incised or scar tissue excised. A transverse incision is made at the dentate line. A proximal flap of anal and distal rectal mucosa, submucosa, and circular muscle is created, mobilized 2–5 cm proximally, and sutured to the distal internal anal sphincter in a tension-free manner. The distal part of the wound is left open, and care is taken to avoid suturing the flap further distally towards the anal verge to avoid mucosal ectropion. Success rates range between 82% and 97%.

L. Y-V advancement flap (Fig. 11.3b): Y-V anoplasty is suitable for a low mild-moderate stenosis. The stricture is incised longitudinally creating the stem of the Y. A V-shaped

Table 11.2 Flap procedures for anal stenosis

Type of flap	Indications	Advantages and Disadvantages
Mucosal advancement flap	Middle and high level stenosis	Ectropion may occur if flap secured too distally at anal verge
Y-V flap	Low mild-moderate stenosis	Narrow tip susceptible to necrosis; narrow tissue coverage with poor proximal reach
V-Y flap	Low moderate-severe stenosis; localized ectropion	Wider coverage than Y-V; poor proximal reach
Diamond flap	Low and middle moderate-severe longer stenosis; Localized ectropion	Provides better coverage more proximally in the anal canal
House flap	Low and middle moderate-severe longer stenosis; ectropion	Provides excellent well-vascularized coverage more proximally in the anal canal with low risk of ischemia; allows coverage of large areas of excision of mucosal ectropion; allows closure of donor site
U flap	Low and middle moderate-severe stenosis; ectropion	Allows coverage of large areas of excision of mucosal ectropion; donor site left open
S flap	Low and middle severe stenosis; extensive ectropion requiring reconstruction of >50% of anal canal	Provides tension-free well-vascularized coverage for an extensive reconstruction; more complex and morbid procedure requiring hospital stay

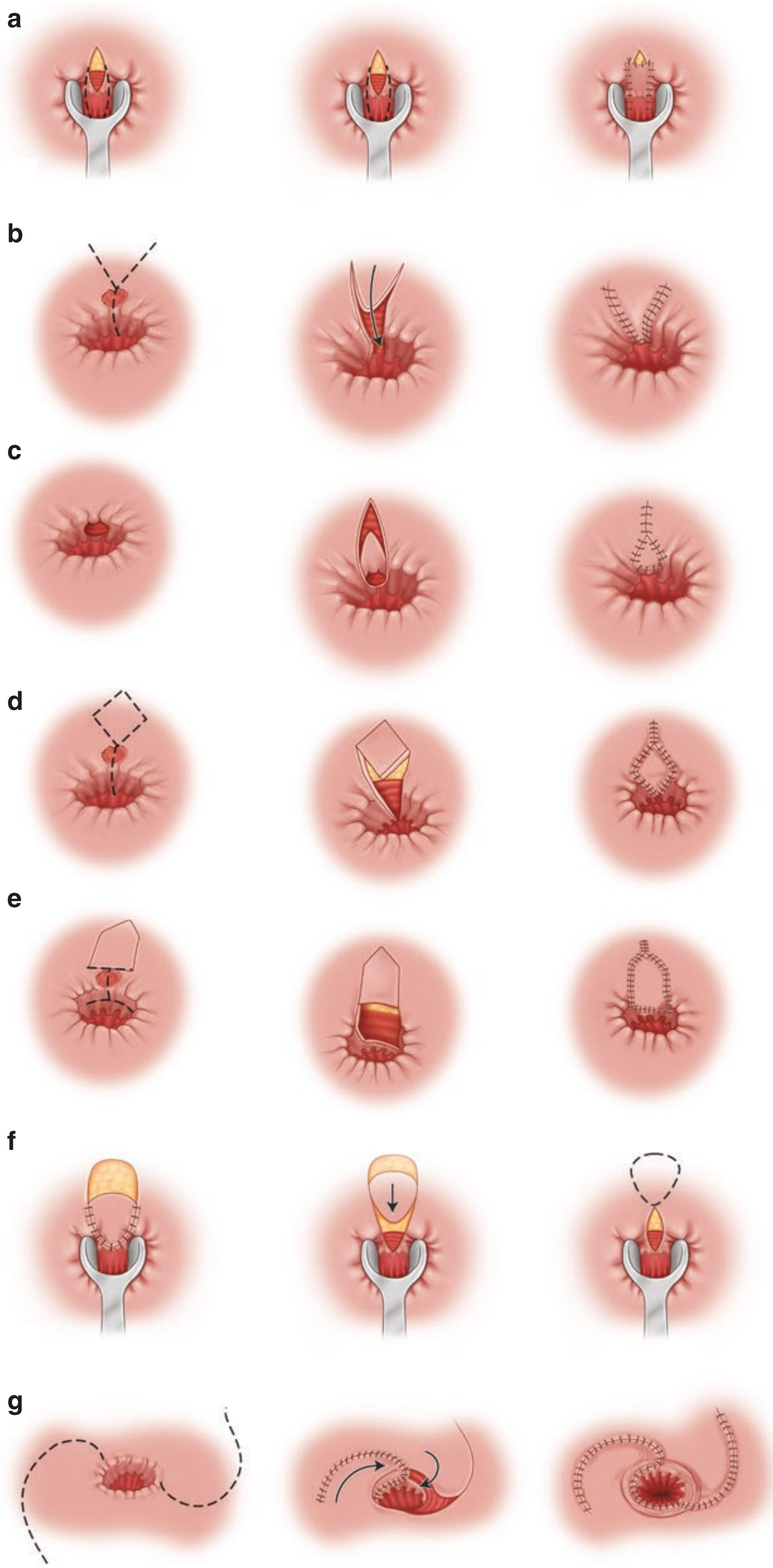

Fig. 11.3 Operative procedures for the surgical treatment of anal stenosis. (**a**) Martin’s anoplasty; (**b**) Y-V advancement flap; (**c**) V-Y advancement flap; (**d**) Diamond-shaped flap; (**e**) House-shaped flap; (**f**) U-shaped flap; (**g**) Rotational S-flap

full thickness flap is then created in the perianal skin with the point of the V originating at the distal end of the stem of the Y. The flap is carried out for 5–8 cm, advanced into the anal canal in a tension-free manner, and sutured to the internal anal sphincter and mucosa with interrupted absorbable sutures. Care is taken to avoid narrowing the width of the flap to prevent ischemia. The length of the flap should not exceed 2–3 times the width of its base. The disadvantage of this flap is the risk of ischemia at the narrow tip of the V which precludes its use for higher, more severe stenoses. Success rates range between 64% and 100%.

M. V-Y advancement flap (Fig. 11.3c): This flap is used for low more severe stenoses as a wider flap of skin can be advanced. After incising the stricture, a V-shaped flap of anal skin is created with the wide base of the V oriented proximally. Care is taken to include underlying subcutaneous tissue as perfusion is partly dependent on the subcutaneous vasculature. The flap is then advanced and sutured in place. The donor site is reapproximated distal to the flap to create the stem of the Y. Compared to Y-V anoplasty, the V-Y anoplasty allows for a wider flap for more severe low level stenosis.

N. Diamond flap (Fig. 11.3d): This procedure is useful for low and mid level longer stenoses, with or without localized ectropion, and is frequently performed bilaterally. The stricture is incised creating a diamond-shaped defect. If an ectropion is present, it is excised conservatively. A diamond shaped flap of skin and underlying subcutaneous tissue is created with the leading proximal half of the flap matching the same dimensions as the defect. Care is taken to avoid undermining the flap to preserve its subcutaneous blood supply. The flap is advanced proximally and sutured to the edges of the defect in a tension-free manner. The donor site is closed primarily. Reported success rates range between 88% and 100%.

O. House flap (Figs. 11.3e and 11.4): The house flap anoplasty allows for significant widening of severe low and mid level long stenosis while allowing for primary closure of the donor site, and is a good option when mucosal ectropion is present. The stricture at the dentate line is incised longitudinally. Proximal and distal transverse incisions centered on the longitudinal incision are made. A house-shaped flap is created with the base positioned proximally at the distal end of the defect, and the apex oriented distally. The width and length of the house should match the width and length of the defect. Subcutaneous tissue is included in the flap and undermining is avoided to prevent ischemia. The flap is sutured in place and the donor site can be closed primarily. For more severe stenosis or extensive ectropion, bilateral house flaps can be performed. This wide flap allows for a significant increase in diameter along a greater length of the anal canal diameter when compared to V-Y and diamond-shaped anoplasties. Furthermore, the risk of ischemia is reduced in comparison to the narrow apex of the Y-V anoplasty. Success rates between 89% and 100% are reported.

P. U-shaped flap (Fig. 11.3f): This broad-based flap is particularly useful when a large mucosal ectropion must be excised. A U-shaped island flap of adjacent anal skin is sutured to the edges of the defect. The donor site is left open to heal by secondary intention.

Q. Rotational S flap (Fig. 11.3g): The S flap is more commonly used to reconstruct large anal canal defects created after extensive excisional procedures for conditions such as Paget's disease. It can be used for extensive anal stenosis and mucosal ectropion associated with a Whitehead deformity if more than 50% of the circumference of the anal canal requires reconstruction. It is typically performed bilaterally. Full-thickness S-shaped flaps on the right and left centered on the anal canal are created with the base equal to its length. The flaps are rotated into the anal canal and sutured to the edges of the defect created by excision of the scar and ectropion.

Fig. 11.4 House flap. (**a**) Anal stenosis with mucosal ectropion after hemorrhoidectomy; (**b**) House flap procedure; (**c**) Final result after healing

R. Patients with a purely functional stenosis will benefit from lateral internal sphincterotomy should conservative measures fail. An open approach without reapproximation of the incision may allow release of any overlying fibrosis.

S. The majority of flaps can be performed in the outpatient setting. Extensive bilateral flaps may require a short hospital admission. Patients are instructed to remove dressings on the first postoperative day or earlier if needed to allow passage of a bowel movement. A high fiber diet, fiber supplementation, and stool softeners are recommended. Gentle cleansing after a bowel movement is encouraged. Bowel confinement is not recommended even for extensive procedures. Oral antibiotics are prescribed for 2 weeks. Patients are seen in follow-up at 2 weeks and 6 weeks postoperatively. A gentle digital rectal exam is performed at 6 weeks. Further follow-up is recommended if wound healing is not complete.

T. Complications after flap procedures include ischemic flap necrosis, infection or abscess, fecal impaction, suture line dehiscence (from excessive tension, excessively hard stools, or vigorous wiping), inadequate correction of the stenosis with persistent symptoms, ectropion if a mucosal flap is secured too close to the anal verge, donor site wound problems, pruritus, urinary tract infections, and fecal incontinence. Dehiscence is usually treated conservatively with wound care until healing is complete.

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12 Anorectal Abscess

Zhaomin Xu and Jenny R. Speranza

Refer to Algorithm in Fig. 12.1

A. The majority of anorectal abscesses result from cryptoglandular infections. Anal glands empty into the anal crypts at the level of the dentate line. Obstruction of the ducts and glands lead to stasis, bacterial overgrowth, infection, and ultimately abscess formation. These abscesses may lead to a resultant fistula if there is epithelialization of the draining tract.

B. Approximately 10% of anorectal abscesses are thought to be associated with some predisposing factors such as Crohn's disease, trauma, chronic inflammation, immunodeficiency, sexually transmitted diseases, malignancy, or foreign bodies. Abscesses are categorized into four types dependent on their anatomic positions: perianal, ischiorectal, intersphincteric, and supralevator (Fig. 12.2). The most common types are perianal and ischiorectal. When an abscess spreads circumferentially through the intersphincteric, deep postanal space, or ischiorectal spaces bilaterally, a horseshoe abscess may result.

C. The most common presenting symptoms are constant, throbbing acute pain and local swelling. Perianal abscesses are typically superficial and may be accompanied by erythema and fluctuance overlying the abscess. Because ischiorectal abscesses arise more laterally in the ischiorectal space, symptoms may actually occur on the buttock and anal margin as opposed to at the anal verge. Patients with intersphincteric abscesses may not have any superficial symptoms because the abscess arises in the intersphincteric space. Similarly, Patients with supralevator abscess may also lack visible external signs, but complain of gluteal pain or pressure. If spontaneous drainage occurs, then there may be visible purulent drainage.

D. Any evidence of a systemic infection in the form of tachycardia, fevers, chills, and leukocytosis or leukopenia should prompt emergent drainage.

E. If possible, a digital rectal examination should be done, which may demonstrate tenderness or fullness along the rectal wall or mass. Careful observation may reveal an external opening suggestive of a fistula-in-ano. Features such as large skin tags or multiple fistula openings may suggest an underlying diagnosis of Crohn's disease.

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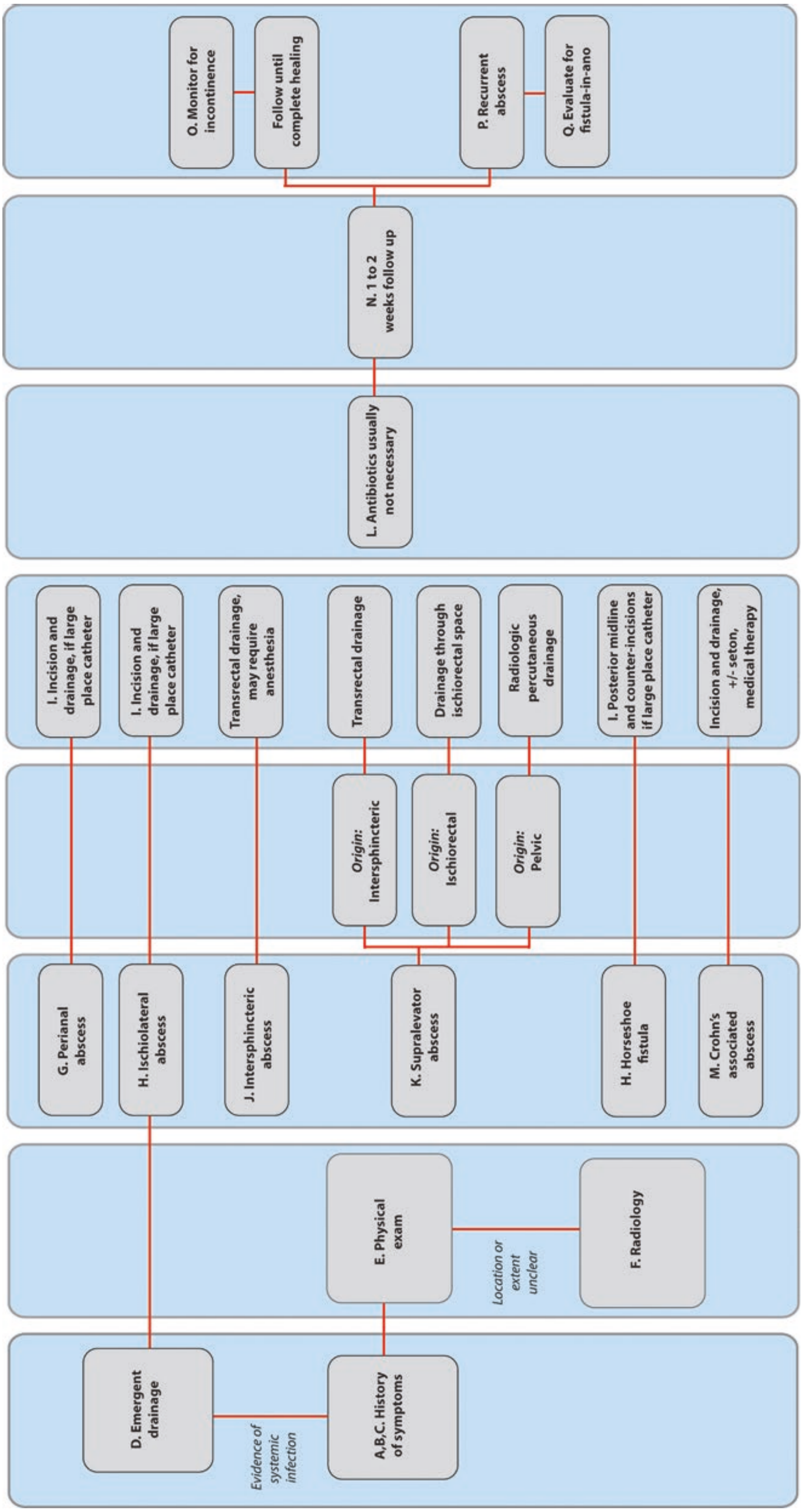

Fig. 12.1 Algorithm for anorectal abscess

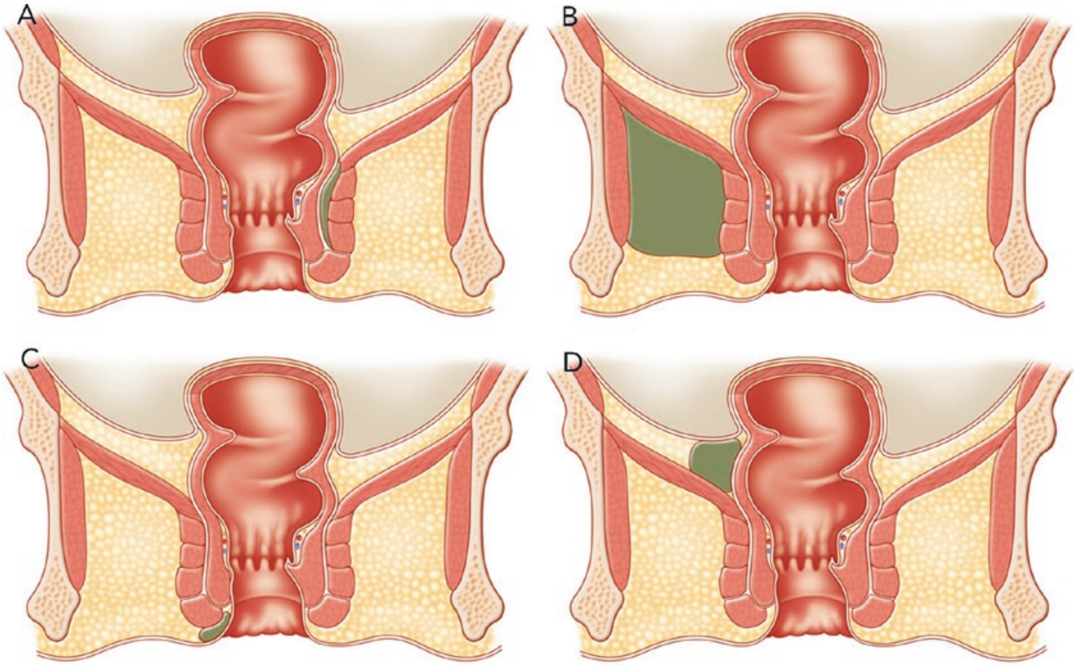

Fig. 12.2 Diagram of the locations of common anorectal abscesses. A: Intersphincteric abscess; B: Ischioanal abscess. C: Perianal abscess; D: Supralevator abscess. With permission from Nicole M. Saur and Dana R. Sands. Anorectal Abscess. Zutshi M, ed. Anorectal Disease. Springer Nature 2016

F. In general, a diagnosis of anorectal abscess is clinical and does not require further imaging. For complex abscesses, endoanal ultrasound, MRI, or CT scan may assist in delineating the extent of abscesses.
G. The over-riding principal behind the treatment of anorectal abscesses is timely incision and drainage. In the majority of cases, perianal abscesses can be effectively drained under local anesthesia in the office or at bed side. After finding the maximal point of tenderness, the area is infiltrated with lidocaine. A cruciate or elliptical incision is made across the overlying skin. Effort should be made to stay as close to the anus as possible yet carefully avoiding injury to the sphincter complex. This will minimize the length of any subsequent fistulas that may form. In order to decrease the risk of acute recurrence, the overlying skin can be excised or a drainage catheter can be placed within the cavity. An extra step to break up loculations mechanically can be taken to ensure adequate drainage. However, this should be done with care, especially if the abscess if very close to the anal sphincter. Generally, with an adequate incision, postoperative packing is not necessary unless needed for hemostasis.
H. Large ischiorectal abscesses and horseshoe abscess may require general anesthesia for adequate treatment. While small ischiorectal abscesses can be treated in a similar manner to perianal abscesses with the incision made as close to the anal verge as possible, large ischiorectal and horseshoe abscesses may require an incision over the anococcygeal ligament in the posterior midline to access the deep postanal space followed by counter-incisions over the lateral extensions of the abscess overlying the ischiorectal space. This is referred to as a Hanley procedure. Horseshoe abscesses have a high rate of recurrence ranging between 18% and 50% and may require multiple drainage procedures.

I. An alternative method for large perianal, ischiorectal and horseshoe abscesses is to leave a draining mushroom-tip catheter to allow for adequate drainage and the ability to irrigate periodically in the postoperative period. A small incision can be made overlying the abscess cavity. The cavity is then irrigated and debrided to break up loculations. The catheter is then inserted with a probe. Care should be taken to choose a catheter of an adequate size so that the catheter will not fall out spontaneously nor be difficult to remove in the office. This will allow irrigation postoperatively if there is significant cellulitis and sepsis.

J. Intersphincteric abscesses general require drainage under anesthesia due to pain. Drainage should be performed through the rectum by dividing the internal sphincter along the length of the abscess.

K. Supralevator abscesses can originate from different locations, and hence, treatment should be tailored to where the abscess originates from. A supralevator abscess that originated from an intersphincteric abscess should be treated transrectally as is done for an intersphincteric abscess. However, if treating a supralevator abscess that originated from an ischiorectal abscess, then drainage should be performed through the ischiorectal space. Finally, supralevator abscesses can originate from a pelvic source secondary to diverticulitis, gynecologic infection or Crohn's disease. In these cases, optimal drainage may be achieved through radiologically guided percutaneous drainage followed by treatment of the underlying cause.

L. The addition of antibiotics to routine incision and drainage of an uncomplicated anorectal abscess is generally unnecessary and has not been shown to reduce healing time or recurrence rates. Exceptions are patients that have prosthetic valves, previous bacterial endocarditis, congenital heart disease, heart transplant patients with valvular pathology, extensive soft tissue cellulitis, immunosuppression, diabetes mellitus, or systemic sepsis. Wound cultures are also generally not helpful, however, it may be considered in cases of multiple recurrences or non-healing wounds.

M. The treatment of abscesses in patients with Crohn's disease deserves special care. Perianal pathology occurs in 40–80% of Crohn's patients. Crohn's patients typically have a high rate of poor wound healing and risk of sphincter injury due to chronic inflammation leading to large amounts of local fibrosis. Management should be focused on alleviation of perianal sepsis and preservation of continence. Hence, surgical management of anorectal abscesses in these patients should center around prolonged drainage with the use of catheters or setons. Medical management has also been advocated in Crohn's patients using antibiotics such as metronidazole and ciprofloxacin to provide further symptomatic relief.

N. Postoperatively, patients should be instructed to take fiber, non-narcotic analgesia as needed, and perform sitz baths. Patients may be re-evaluated in the office as soon as 1–2 weeks depending on the complexity of the procedure and follow up should continue until complete healing has occurred.

O. Incontinence may occur after the incision and drainage of an anorectal abscess. This can result from sepsis and tissue necrosis secondary to the infection. Baseline continence should be documented prior to any surgical procedure. Iatrogenic damage to the sphincter complex can occur during the drainage procedure. Subsequent incontinence can also occur if there is damage to the puborectalis muscle during the drainage of a supralevator abscess.

P. Recurrence is more common in those with a history of abscesses. Recurrence typically occurs due to incomplete drainage, a missed abscess in an adjacent space, or an undiagnosed fistula. Other reasons for recurrence that should be entertained if the usual causes have been ruled out are hidradenitis suppurativa, Crohn's disease, immunosuppression, tuberculosis, trauma, and foreign bodies.

Q. Approximately 30–50% of patients with an anorectal abscess will develop a fistula-in-ano.

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Anal Conditions: Fistula-in-Ano

13

Sebastien Lachance and Marylise Boutros

Refer to Algorithm in Fig. 13.1

A. A fistula refers to an abnormal connection between two epithelial lined surfaces, and in the case of a fistula-in-ano, is characterized as a tract between the anorectum and perianal skin. Cryptoglandular disease encompasses ~90% of cases, while other etiologies of anal fistula are less common including postoperative or trauma (3%), inflammatory bowel disease (3%), anal fissure (3%), and tuberculosis (<1%). In cryptoglandular disease, the fistula originates from an infected anal crypt gland, which is caused by inspissated debris or stool that is blocking the gland. The anal canal typically consists of 8–10 anal crypt glands at the level of the dentate line. These glands penetrate the internal sphincter, terminating in the intersphincteric plane. When a perianal abscess does occur, pus collects within the crypt and then drains into the perianal skin through this fistulous tract. Following such an episode, the fistula will fail to heal in 26–38% of cases, thereby resulting in a chronic fistula.

B. The incidence of fistula-in-ano is estimated at 2 per 10,000 person-years. This disease presents at a mean age of 40 years (range 20–60); and compared with women, men are twice as likely to develop an anal fistula. Symptoms of an anal fistula are quite variable, and depend on the location of the external opening and the complexity of the tract. These may include discharge (65%), pain (34%), swelling (24%), bleeding (12%), and diarrhea (5%). If a patient presents with fever and/or malaise with pain, cellulitis, or a bulge on the perianal skin, an anal concomitant abscess should be suspected. In the context of cryptoglandular fistulas, the fistula is usually preceded by a history of anorectal abscess that drained spontaneously or by an incision and drainage. Conversely, severe pain, abdominal cramping, bloating, early satiety, or weight loss should raise suspicion of underlying Crohn's disease or malignancy. Finally, the patient's history must be carefully examined for any symptoms of incontinence, as this may reflect underlying sphincter impairment and will impact surgical decision-making.

C. Physical examination is essential to determine the optimal treatment strategy, which may be conducted in the outpatient clinic setting. However, if the patient experiences discomfort, a thorough examination in the operating room is always required to accurately plan the definitive management. If

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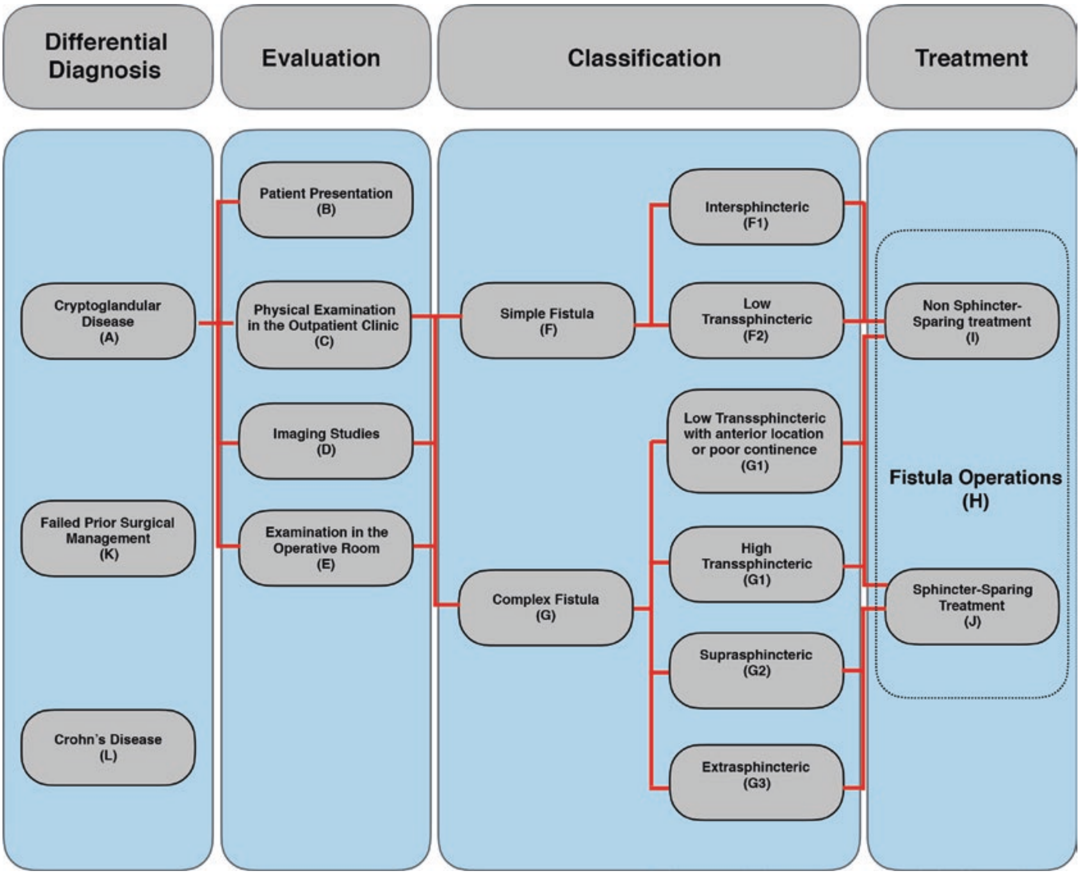

Fig. 13.1 Algorithm for fistula in ano

possible, examination in the outpatient clinic allows identification of the external opening of the fistula, possible identification of the internal opening, and performance of a digital rectal examination to assess sphincter tone (see section E for a detailed explanation of the physical examination).

D. Imaging studies are of limited value for most patients with a first presentation of uncomplicated fistula-in-ano. However, imaging is helpful in select patients with recurrent fistulas, occult abscesses, secondary tract formation, or Crohn's disease. Magnetic resonance imaging (MRI) yields excellent intrinsic soft-tissue resolution, which can depict the fistula tract in the context of the surrounding structures. Endoanal ultrasound (EUS) offers a 360° view of the anal canal, delineating the relationship of the tract with the anal sphincters and the internal opening. However, EUS is highly operator-dependent. MRI is the gold standard modality with 90% accuracy, whereas EUS achieves a slightly lower accuracy of 80–89%. Despite MRI and EUS demonstrating similar sensitivities (87%), MRI has a higher specificity (69% versus 43%, respectively). In addition to MRI, a computerized tomography (CT) scan can be used to evaluate pelvic extensions of anorectal suppuration—though is not often useful for fistula anatomy. Due to the accuracy of the aforementioned studies, fistulography is no longer recommended.

E. The goal of the examination in the operating room is to delineate the relationship of the fistula tract with the sphincter muscles and to appropriately classify the fistula according to the Parks et al. classification (See Fig. 15.3), as this will guide the treatment strategy. It is the

Fig. 13.2 External opening of a fistula. *Note* the long distance between the external opening and the internal opening, hinting to the complexity of this suprasphincteric fistula

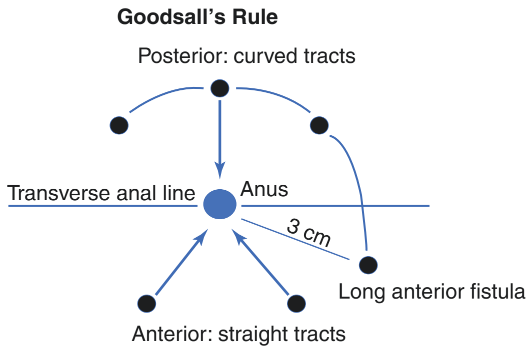

Fig. 13.3 Illustration of Goodsall's Rule (Reused with permission. Feingold DL, Kiely JM. Cannot Find Internal Opening of Fistula-in-Ano. In: Lee SW, Steele SR, Feingold DL, Ross HM, Rivadeneira DE, eds. Colorectal Surgery Consultation. Tips and Tricks for the Management of Operative Challenges. Springer Nature, 2019;pp.:111–113 © Springer Nature)

authors' preference to perform the physical examination in the prone jack-knife position. *On inspection*, patients may present with an acute fistulous abscess as evidenced by signs of inflammation such as erythema, swelling, and induration. In the chronic state, the external opening is seen as a red elevation of granulated tissue or a pinpoint opening (Fig. 13.2). *On palpation*, purulent or serosanguineous discharge can usually be elicited. In addition, skin palpation may reveal a cord structure corresponding to a superficial fistula tract. *On digital rectal examination and anoscopy*, the internal opening is not always obvious. As stated by Goodsall's rule (Fig. 13.3), if there is an external opening posterior to the coronal plane, the internal opening is likely to be found in the dorsal midline; if the external opening is anterior, the tract has a radial trajectory to the nearest crypt. As a general rule, the more lateral and numerous the external openings, the more complex the fistula. When in doubt, *probing* is an option that allows identification of primary openings in the majority of patients. A wide variety of probes with different sizes, shapes, and malleability are available (Fig. 13.4). This portion of the examination involves introducing the metallic probe into the external opening of the fistula in order to identify its trajectory, any side branches, and the internal opening. Probing must be gently conducted with care taken to avoid creation of a false passage into the anorectum. If unsuccessful, methylene blue or dilute hydrogen peroxide can be injected into the external opening using an olive-tip metal catheter (Fig. 13.5).

F. *Simple anal fistulas* include those classified by Parks et al. (See Fig. 15.3) as intersphincteric or low transsphincteric, and involve less than 30% of the external sphincter.

F1. *Intersphincteric fistulas* are the most common, accounting for 31–70% of all anal fistulas. The fistula begins at the dentate line and completes its course at the anal verge, tracking along the intersphincteric plane. Most intersphincteric fistulas result from a perianal abscess.

F2. *Transsphincteric fistulas* begin at the dentate line, tracking up to the perianal skin overlying the ischiorectal fossa. The tract encompasses a variable portion of the internal and external sphincters. Its level determines how much muscle will be divided if a fistulotomy is elected, and its potential impact on continence. A low transsphincteric fistula encompasses less than 30% of the external sphincter. Transsphincteric fistulas comprise between 21% and 53% of anal fistulas and are usually preceded by an ischiorectal abscess.

Fig. 13.4 Metal Lockhart-Mummery fistula probes

Fig. 13.5 Olive-tipped metal catheter to be used for injection into the external opening

G. *Complex fistulas* comprise roughly 50% of all fistulas, and include high transsphincteric fistulas, anterior transsphincteric fistulas in females, any transsphincteric fistulas in patients with impaired continence, extrasphincteric fistulas, and suprasphincteric fistulas (Fig. 13.2).

   G1. *High transsphincteric fistula* tracts follow the same trajectory described in F1, except that more than 30% of the external sphincter is involved. Anterior transsphincteric fistulas in women should be managed as a complex fistula as these patients have less sphincter muscle bulk at this location. Likewise, any transsphincteric fistula in a patient with impaired continence should be managed as a complex fistula.

   G2. *Suprasphincteric fistulas* start at the dentate line and encircle the entire sphincter complex. The tract traverses over the top of the puborectalis muscle and through the levator plate to the ischiorectal fossa and the overlying skin. The incidence varies between 2 and 20%.

G3. *Extrasphincteric fistulas* lie outside the sphincter complex. The tract passes from the perianal skin to the ischiorectal fossa and the levator ani, thereafter penetrating the rectal wall. This type of fistula should raise suspicion of an etiology other than cryptoglandular disease including trauma, inflammatory bowel disease, diverticulitis, or malignancy. These intra-abdominal etiologies are best assessed by CT scan. Alternatively, a transsphincteric fistula with a high blind tract passing through the levator ani and the rectum is another potential etiology for an extrasphincteric fistula. Fortunately, this occurs rarely, with an incidence of 2–3%.

H. Fistula operations can be broadly categorized as: (1) *cutting procedures or non-sphincter sparing*, or (2) *sphincter-sparing* procedures. In general, non-sphincter sparing operations have much better success rates within a shorter interval of time compared to sphincter-sparing procedures. However, non-sphincter sparing operations require division or destruction of some degree of sphincter muscle making it critical to select the most suitable patient and fistula for these operations (Fig. 13.6).

I. *Non sphincter-sparing techniques* (Table 13.1) are typically used in the treatment of simple fistulas. One-stage fistulotomy is the treatment of choice and involves opening the fistula tract along its trajectory (Fig. 13.7) after successful probing of the entire tract, and identification of both the internal and external openings. This operation has excellent long-term success rates ranging from 70 to 100%, and a high patient satisfaction rate up to 87%. Although fistulotomy has excellent cure rates, this operation carries the risk of impaired continence in 15 to 44% of patients, with 30% reporting incontinence to flatus, 4% to soft stools, and 2% to hard stools. Despite a similar recurrence rate, fistulectomy (Fig. 13.7), defined as complete excision of the fistula tract, is not favored owing to the complexity of the operation and slower healing time. Another non-sphincter sparing option is the use of a cutting seton. This procedure requires division of all the skin and subcutaneous tissue involved in the fistula tract, while a suture is placed within the tract and snuggly tied around the involved sphincter muscle. The patient is subsequently seen every 4–6 weeks to tighten the seton. The resultant gradual division of the involved sphincter muscle theoretically allows healing to occur in a step-wise fashion, thus aiming to preserve sphincter function. Despite its high success rate (up to 94%), long-term incontinence rates may still exceed 30%. Thus, regardless of the technique, any sphincter division must be undertaken with caution and knowledge of the patient's preoperative functional status. When in doubt, it is wise to treat a simple fistula as a complex one.

J. The treatment of *complex fistulas* is challenging and often may require multiple

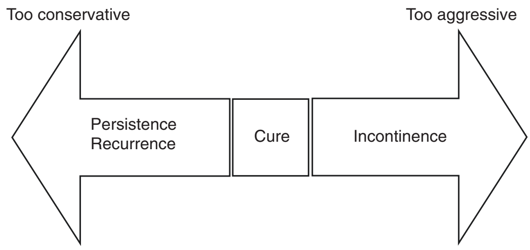

Fig. 13.6 Principles of surgical treatment of anal fistulas

Table 13.1 Treatment Options for Fistula-in-Ano

Non Sphincter-Sparing Techniques (I)
Cutting Seton
Fistulotomy
Fistulectomy
Sphincter-Sparing Techniques (J)
Draining Seton
Fibrin Glue
Anal Fistula Plug (Surgisis® Anal Fistula Plug™)
Ligation of the Intersphincteric Fistula Tract (LIFT)
Flaps (Excision and Closure, Mucosal, Skin)
Video-Assisted Anal Fistula Treatment (VAAFT)
Fistula-Tract Laser Closure (FiLaCTM)

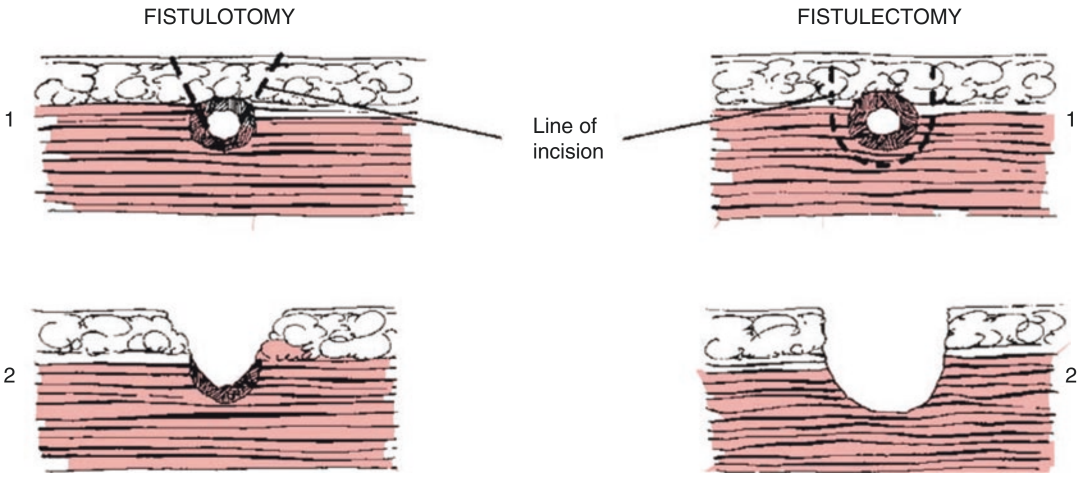

Fig. 13.7 Fistulotomy versus fistulectomy (Source: Gordon PH, Nivatvongs S. Principles and Practice of Surgery for the Colon, Rectum and Anus, 3rd Edition. Informa Health Care, New York 2007;pp.:222. Used with permission from the editors)

operations. Therefore, to avoid the risk of incontinence, sphincter-sparing options are usually favored (Table 13.1). A draining seton positioned in the fistula tract is the first step in the treatment of complex fistulas (Fig. 13.8). This promotes preservation of the anal sphincter complex, maturation of the fistula tract, and control of the septic focus. The Ligation of the Intersphincteric Fistula Tract (LIFT) procedure is an attractive option for high transsphincteric fistulas, and consists of identifying, ligating, and dividing the fistula tract within the intersphincteric groove (See Fig. 15.6). Primary healing rates range from 71 to 82%. However, the LIFT procedure can prove to be technically difficult to perform for very high transsphincteric fistulas, and is not applicable for suprasphincteric and extrasphincteric fistulas. Fibrin glue and anal fistula plugs are two options that consist of filling the tract with biological material. Although these techniques may play a role in the management of complex fistulas, the high failure rate (up to 80%) and higher cost render these options less attractive. Endorectal advancement flaps (Fig. 13.9) can yield success rates up to 70% in experienced hands. Wide-based flaps with mucosal tissue provide coverage of the internal opening, allowing the tract to heal and close. In order to enhance healing, mucosal flaps have recently been combined with Video-Assisted Ablation of the Fistula Tract (VAAFT) or the Fistula Laser Closing (FiLAC™) device. VAAFT allows for tract cauterization under direct visualization, while FiLAC™ relies on radial-emitting disposable laser fibers to ablate the tract. However, success rates reported with these added procedures do not exceed those of flaps alone.

K. Recurrence is common, especially with sphincter-sparing approaches, and can manifest as persistent drainage, abscess, or inflammation at the external fistula opening. Factors that have been associated with recurrence include complex fistulas, horseshoe extensions, previous fistula surgery, sphincter-sparing approaches, lack of identi-

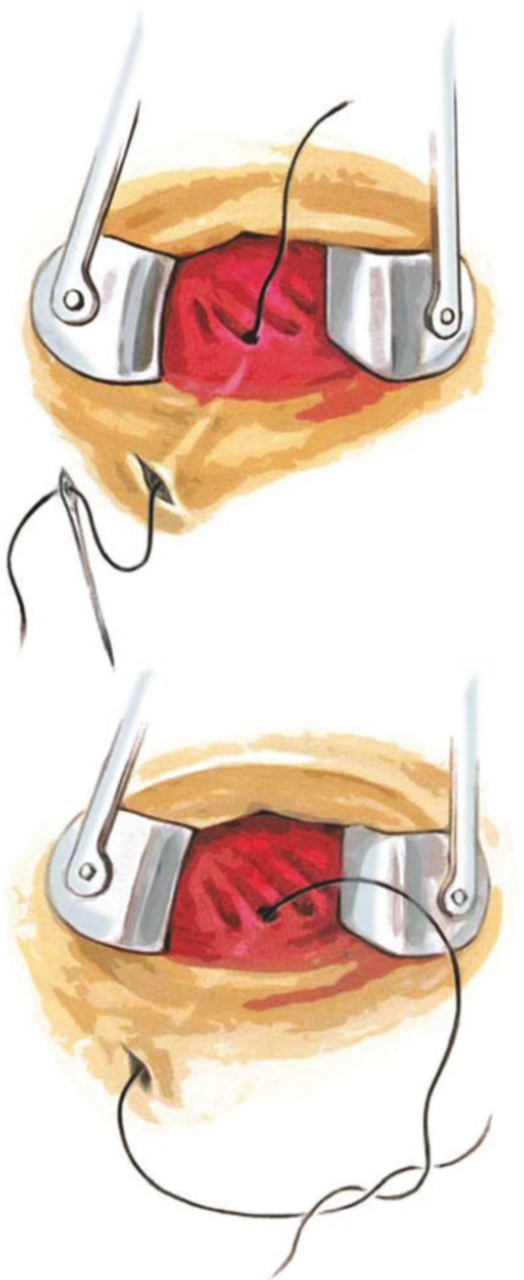

Fig. 13.8 Insertion of a seton (Source: Wexner SD, Fleshman JW, eds. Master Techniques in General Surgery. Colon and Rectal Surgery: Anorectal Operations. Wolters Kluwer, Philadelphia 2012;pp.:66. Used with permission)

fication of the internal opening, and surgeon experience. One should be mindful that recurrence might herald another etiology, such as Crohn's disease, thereby stressing the importance of repeating a patient's evaluation. Recurrent fistulas should be treated as complex fistulas. Caution must be exercised, for every additional surgery carries added risk of failure and continence impairment.

L. Anorectal fistulas develop in 20–30% of patients with Crohn's disease, thus clinicians must consider this etiology in their differential diagnosis. In fact, fistula-in-ano can be the primary manifestation of Crohn's disease in up to 30% of patients. Compared to cryptoglandular disease, the mainstay of treatment is not surgical but medical. Endoscopy and imaging are critical to delineate the extent of disease and the presence of any inflammation in the rectum. A multidisciplinary approach involving a gastroenterologist is strongly recommended. Draining setons are initially used to control sepsis. In the presence of proctitis, medical treatment with infliximab with or without antibiotics is required. In the absence of proctitis, fistulas can be treated medically or surgically. Overall, remission can be achieved with medical management in 50% of patients with Crohn's-related fistula-in-ano. Surgical intervention must be undertaken with great caution and after careful preoperative counseling due to a significant risk of incontinence as well as multiple procedures over the patient's lifetime. If an operative approach is chosen, sphincter-sparing techniques are used to limit any damage to the sphincters, as these patients may require further interventions for other fistulas in the future. Finally, with severe disease in the setting of Crohn's, diversion or even proctectomy may be required.

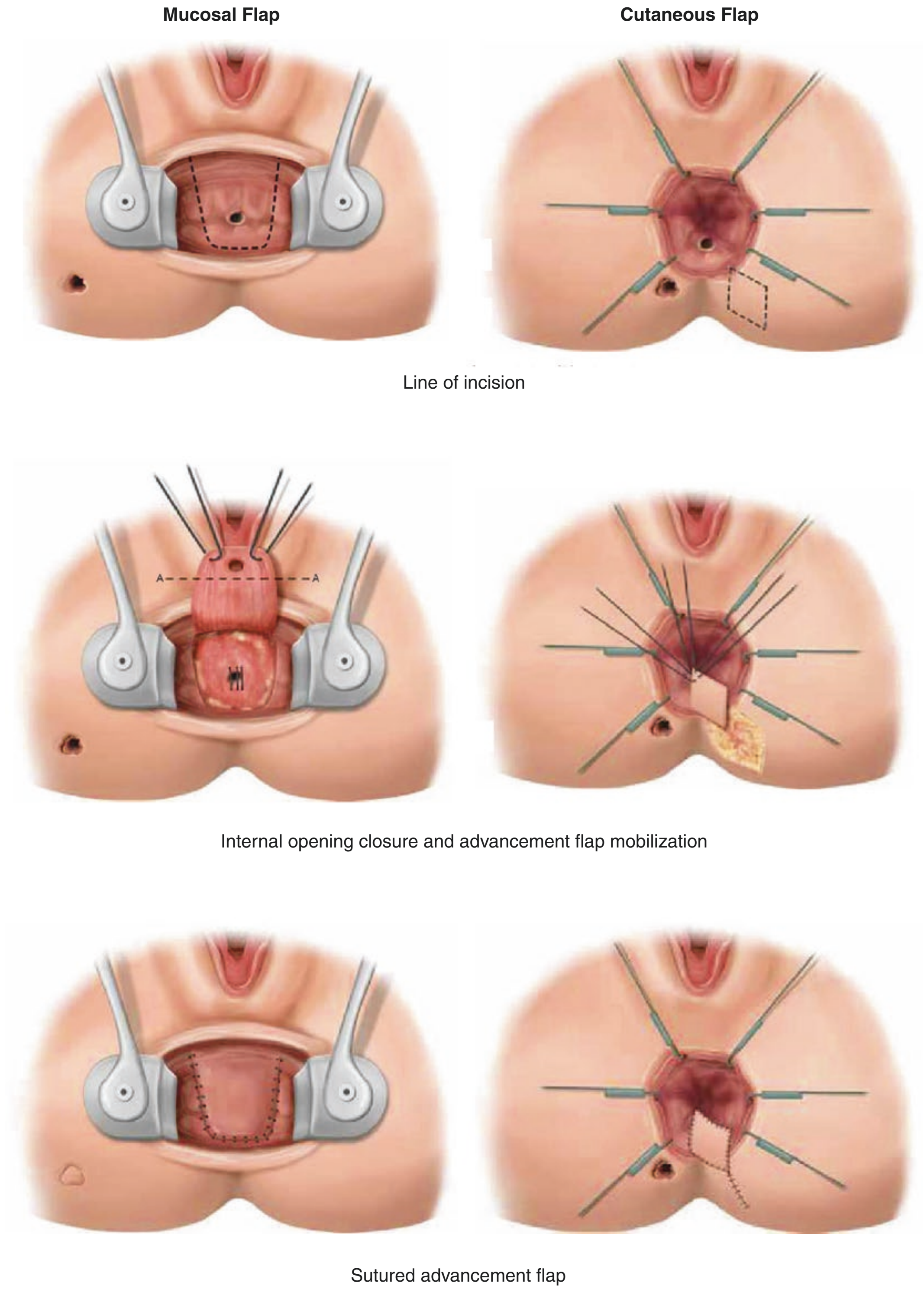

Fig. 13.9 Flaps (Source: Wexner SD, Fleshman JW, eds. Master Techniques in General Surgery. Colon and Rectal Surgery: Anorectal Operations. Wolters Kluwer, Philadelphia 2012. Chap. 5. Used with permission)

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Anal Conditions: Rectovaginal Fistula

14

Jennifer E. Hrabe and Tracy L. Hull

Refer to Algorithm in Fig. 14.1

Background

Rectovaginal fistulas are socially and physically disabling, emotionally taxing, and a painful condition for patients and often are technically challenging for the treating surgeon. The term "rectovaginal fistula" is generally applied to all abnormal connections between the rectum or anus and vagina. Fistulous connections between the upper and mid rectum and the vagina are often related to patients having had hysterectomy.

Surgical treatment generally includes resection of the bowel and re-anastomosis, often with fecal diversion. These will not be covered here. Instead, we focus on anovaginal, anoperineal, ileal pouch-vaginal, and low rectovaginal fistulas, but will use the term "rectovaginal fistula" (RVF) broadly to encompass these conditions.

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Etiology

The most common cause of RVF is obstetric injury, either from prolonged labor with associated ischemia of the rectovaginal septum and subsequent tissue necrosis, or from traumatic injury including episiotomy or perineal lacerations. Crohn's disease (CD) is the second most common etiology of RVF, and up to 10% of females will suffer this complication. Ulcerative colitis is rarely associated with RVF. Other common causes of RVF are cryptoglandular disease, malignancy, complications of radiation proctitis, and iatrogenic injury. Additional described etiologies include infections in the setting of HIV and violent sexual trauma. Understanding the etiology of the fistula is critical as it can influence the choice of repair.

Evaluation

A. In Office Evaluation

Evaluating the patient begins with a careful history gathering (Fig. 14.1). Symptoms patients complain of include foul smelling or purulent discharge per vagina, gas or stool passed per vagina, incontinence, pain, dyspareunia, and a history of repeated urinary tract and vaginal infections. Bowel habits must be ascertained. If there is frequent diarrheal stools, medical treatments to thicken stool can decrease the

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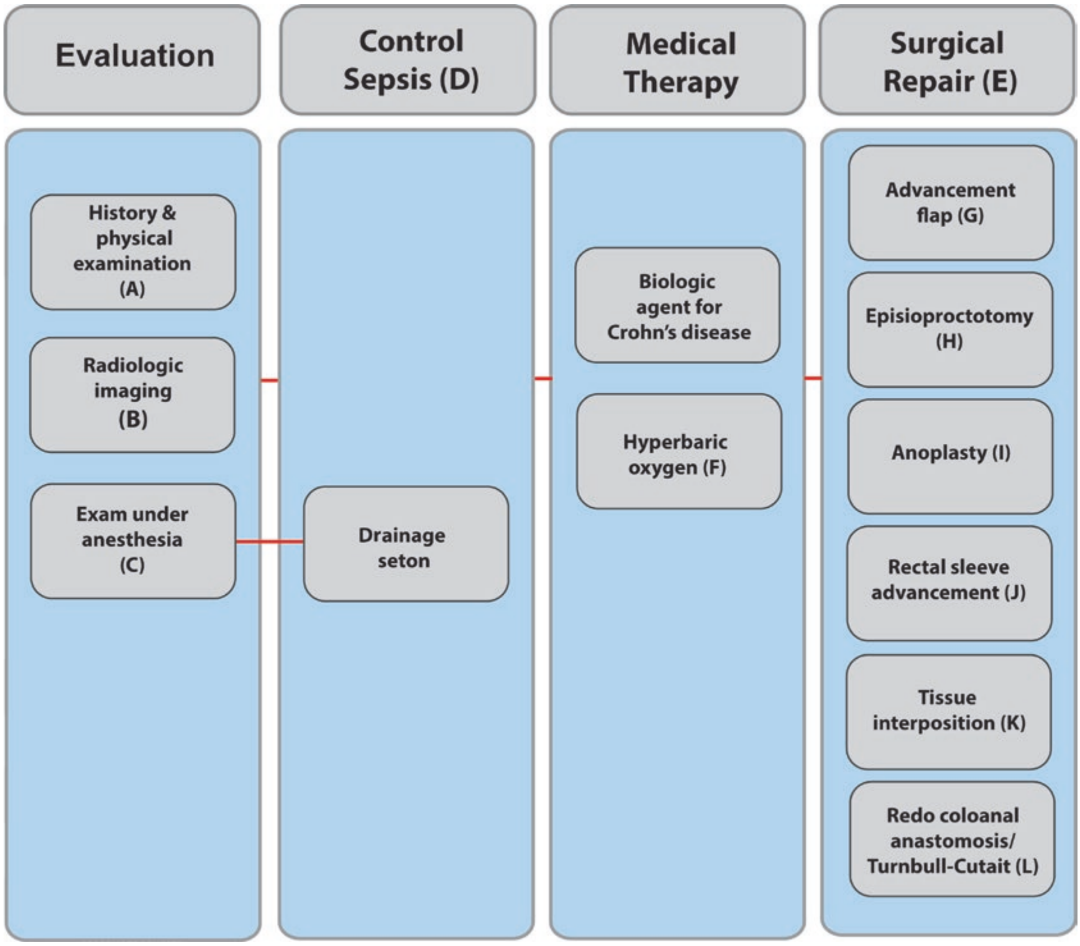

Fig. 14.1 Evaluation and treatment algorithm for rectovaginal fistula

incontinence. Assessing quality of life and how the RVF affects patients is critical. In the rare instance in which a patient has a fistula but has no medical or psychosocial adverse effects from it, it may not make sense to undertake a repair.

The evaluation must include the patient's past medical history, focusing on obstetric history (how long was the labor, did they have an episiotomy or a tear and was it repaired, were forceps used in the delivery); signs or symptoms suggestive of Crohn's disease; and a history or prior malignancy, pelvic radiation, HIV infection, or sexual trauma. As many patients have multiple repairs attempted, it is mandatory to obtain the operative reports of previous repairs.

The office physical exam should include an evaluation of the abdomen in the case the patient requires fecal diversion. A thorough exam of the vaginal, perineum, and anus is essential. The vaginal fistula opening may appear as a small dimple. Assess for signs of local sepsis: fluctuance, erythema, purulent drainage, tenderness to palpation. Sphincter tone should be evaluated with the examiner feeling for muscle contraction on squeeze. If the patient has had previous repairs, evaluate the local tissue and scar. Stigmata of perianal Crohn's disease such as multiple fistulous tracts, waxy skin tags ("elephant ears"), fissures and ulcerations are useful clues. In the setting of previous radiation, evaluate the rectum with either rigid or flexible proctoscopy. In acute radiation proctitis, the rectum will be edematous, hyperemic, and ulcerated. The rectum in chronic proctitis will have loss of normal vascular pattern, loss of compliance, and can have ulcerations and strictures.

B. Imaging

A variety of imaging studies may be useful in evaluation RVF. Radiographic imaging to consider includes an endoluminal ultrasound (ELUS). When combined with instillation of hydrogen peroxide via a small catheter into the fistula, ELUS informs about the complexity of the fistula by demonstrating additional tracts and pockets of fluid collection. It also demonstrates the intactness of the anterior sphincter. The value of vaginograms is limited to delineating high fistulas, as it entails placement of a Foley catheter into the vagina for administration of contrast and insufflation of the balloon. This therefore blocks visualization of low rectal and anovaginal fistulas. For elusive fistulas, magnetic resonance imaging can demonstrate the internal openings on both the anorectal and vaginal sides and show abscesses. The fistula is seen on T2-weighted images and appears as a bright, high signal intensity tract. CT scan has limited utility for local evaluation though will demonstrate abscesses. However, for patients in whom Crohn's disease is suspected, CT enterography should be considered to evaluate for more proximal disease. The "tampon test" includes insertion of a tampon vaginally and small enema with blue dye. The presence of blue dye on the tampon confirms the presence of the fistula though gives no information about its tract or location of vaginal opening.

C. Examination Under Anesthesia

A complete physical exam is critical and if unable to accomplish in the office, whether due to patient discomfort or inability to define the fistula tract, should prompt an examination under anesthesia (EUA). Signs of local sepsis should also lead to an EUA, as adequate drainage and sepsis control are the foundation of successful subsequent treatments. Placement of a loose draining seton is commonly performed at the EUA. Occasionally, a second EUA is needed, either to better define anatomy or to evaluate resolution of sepsis.

Treatment

D. Initial Treatment

Treatment of the fistula often requires surgical intervention, though this should be performed only once all other conditions have been optimized. Fistulas resulting from obstetric injury should not be surgically repaired for at least 3–6 months. Not only will a small fraction of these heal on their own, but time to reduce the inflammation is important for a successful definitive repair. As mentioned above, local sepsis must be controlled, meaning that abscesses must be drained and immature fistula tracts should have a loose draining seton placed to facilitate drainage (Figure 14.1d). Patients with Crohn's disease should be started on a biologic agent, as studies have demonstrated that a proportion (nearly 50%) of Crohn's-related fistulas will heal with medical treatment alone (Figure 14.1e). For patients with severe perianal Crohn's and RVF who are unlikely to heal with even the best local repair, management may stop at medication and draining seton. If the patients have good quality of life with this, this limited approach is preferable to chasing aggressive surgical intervention which can disrupt fecal continence and lead to permanent stoma. Some women require temporary fecal diversion to help control sepsis. The stoma may be kept in place to facilitate healing following the definitive repair, particularly if the repair requires a more extensive approach such as resection and anastomosis. Hyperbaric oxygen may be useful for fibrotic and poorly vascularized tissues (Figure 14.1f).

E. Choosing the Surgical Repair

The decision of which operation to perform needs to be tailored to the etiology of the fistula, the health of the surrounding tissue to be repaired, the goals of the patient, and the familiarity of the surgeon with various repairs. The repair must not be rushed. Patients must be counseled that occasionally multiple repairs are needed to achieve success. While surgeons often have an approach they favor, it is critical that they have multiple

approaches in their technical armamentarium. Finally, the best chance at successful repair is at the first surgery.

F. Fistulotomy

Fistulotomy has limited application in RVF. The fistula must have little to no sphincter muscle involvement, but even in that case the patient is at risk for a keyhole deformity. This can predispose the patient to fecal incontinence.

G. Tissue Advancement Flaps

Tissue advancement flaps are frequently employed in RVF. The rectal advancement flap (Fig. 14.2), when performed correctly and in the optimal patient, has yielded up to 90% healing rate in certain authors' hands. Candidates for this approach should have a healthy rectum and anal canal. Patients with radiation or Crohn's proctitis and those with ulcers or strictures are not appropriate. Operative technique has the patient in prone jackknife or "Kraske" position with the buttocks taped apart. Patients complete a mechanical bowel preparation and receive preoperative antibiotics. While a tongue-shaped flap is often described, we believe this tongue shape leads to ischemia and thus an increased risk of failure. Instead, we recommend excising with electrocautery the mucosa immediately around the fistula, making a curvilinear, horizontally oriented incision at the fistula for approximately 0.5–1 cm on either side, then coring out the fistula. A flap consisting of rectal mucosa, submucosa, and rectal wall is raised cephalad to the internal opening for a distance of 0.5–1 cm. The same can be done in the caudad direction. The fistula tract is then closed in two layers with interrupted absorbable sutures. The first layer reapproximates the internal sphincter muscle and the second layer is full thickness of all three layers: mucosa, submucosa, and muscle. Suture with a 5/8 curved needle (e.g. UR-6 Ethicon, Cincinnati, OH or GU-46, Covidien, Minneapolis, MN) allows deep and robust bites of tissue. Before starting to close the second layer, the integrity of the first layer can be checked by instilling saline into the vaginal opening.

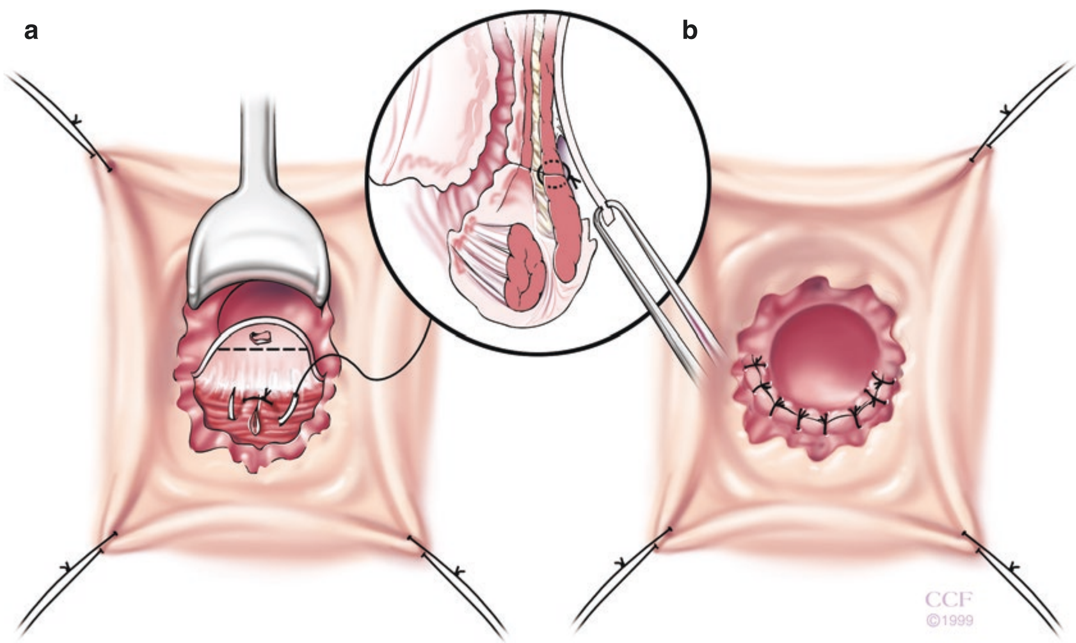

Fig. 14.2 Rectal advancement flap. (**a**) Flap has been dissected cephalad and caudad, internal sphincter approximated. Inset showing depth of bites for approximation. (**b**) Flap mucosa is closed over fistula opening, taking mucosa, submucosa, and muscle. Closed with interrupted absorbable sutures (*Reprinted with permission, Cleveland Clinic Center for Medical Art and Photography © 2008–2016. All rights reserved*)

For patients with an anterior sphincter defect, some authors dissuade the use of rectal advancement flaps. Others describe pairing a transrectal advancement flap with a transperineal overlapping sphincteroplasty. Whether the sphincteroplasty is performed, the vaginal or perineal external fistula orifice is left open to drain. Postoperatively, maintaining patients on bed rest and nil per os for a day or two following the procedure has been described to keep the anal muscles free from stimulation, though this is far from uniform practice. For patients whose fistulas recur, rectal advancement flaps can be repeated, though the healing rate has been shown to drop by one third for the second repair versus the first.

H. Episioproctotomy

An alternative approach for women with anterior sphincter defects with an RVF is the episioproctotomy, Fig. 14.3. While this approach is less widespread within colorectal surgery, it offers healing rates at least equivalent to that of advancement flaps and has been described for a range of RVF etiologies. As with the advancement flap, patients undergo bowel preparation and preoperative antibiotics and are placed prone. A probe is placed through the fistula and a fistulotomy is performed. The muscle ends are identified laterally and mobilized. The rectal mucosa is closed, then an overlapping sphincteroplasty is completed. The vaginal mucosa and then perineal skin is then closed.

I. Anoplasty

Anocutaneous flaps (anoplasty) are less often described for RVF, but do play a role in low fistulas where it may not be feasible to mobilize an advancement flap to reach the fistula opening. The tissue surrounding the fistula opening is debrided, the fistula is cored out and closed with interrupted sutures. A number of flap configurations are available for anal stenosis, but generally an island of skin and fatty subcutaneous tissue is mobilized from the anal verge/margin and then advanced proximally to cover the fistula. This repair requires healthy, pliable anal tissue and is not a good option in patients with severe perianal Crohn's disease or who have scar tissue from previous repairs.

J. Rectal Sleeve Advancement Flap

For patients with extensive anal canal ulcerations or stricturing but with healthy, well vascularized, and distensible rectal tissue, the rectal sleeve advancement flap can be considered, Fig. 14.4. The approach offers an alternative to proctectomy or permanent diversion, such as for patients with severe, disabling perianal Crohn's disease. Preoperative preparation and positioning is the same as previously mentioned. A circumferential incision is made distal to the fistula opening, at or just distal to the dentate line. The incision is carried through mucosa, submucosa, and just a scant few fibers of the internal sphincter. A sleeve flap is raised in a cephalad direction with the dissection in the supralevator space. Mobilization continues until the rectal sleeve can be advanced without tension to the point of planned anastomosis. Prior to the anastomosis, the fistula tract is debrided and closed on the rectal side, while the vaginal opening is left open to drain. Attention is turned back to the sleeve, where the rim of unhealthy tissue is sharply excised, and then the anastomosis from rectum to anoderm is completed using interrupted absorbable sutures. Both the patient and the surgeon must be prepared for an abdominal incision and intra-abdominal colonic mobilization or even proctectomy with diversion, if a tension-free anastomosis cannot be created. As this is functionally a coloanal anastomosis, we almost always divert patients undergoing rectal sleeve advancement flaps.

Ileoanal Pouch-Vaginal Fistulas

Special mention is made of ileoanal pouch-vaginal fistulas. These can be repaired with modifications of aforementioned procedures including ileal advancement flap, or transanal mucosectomy and pouch-anal sutured anastomosis. As with any fistula, control of sepsis is an essential first step and we nearly always employ fecal diversion. For fistulas at or distal to the anastomosis, mucosectomy and full

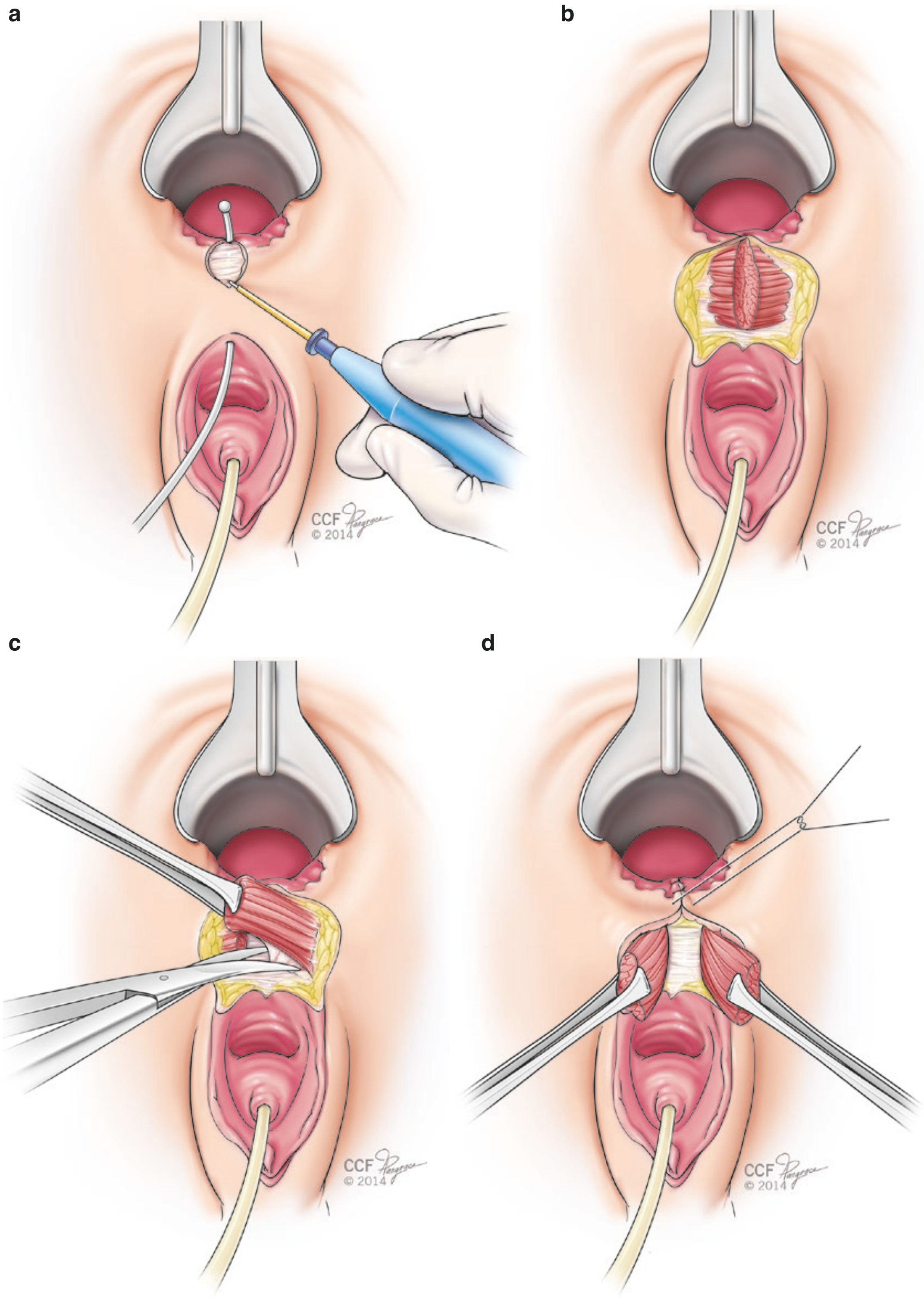

Fig. 14.3 Episioproctotomy. (**a**, **b**) A complete fistulotomy is performed. The fistula tract is debrided. (**a**) Muscles are identified laterally and mobilized. (**b**) The rectal mucosa is closed. (**e**–**g**) An overlapping repair of sphincter muscles is followed by closure of vaginal mucosa and perineal skin with interrupted absorbable sutures (*Reprinted with permission, Cleveland Clinic Center for Medical Art and Photography © 2008–2016. All rights reserved*)

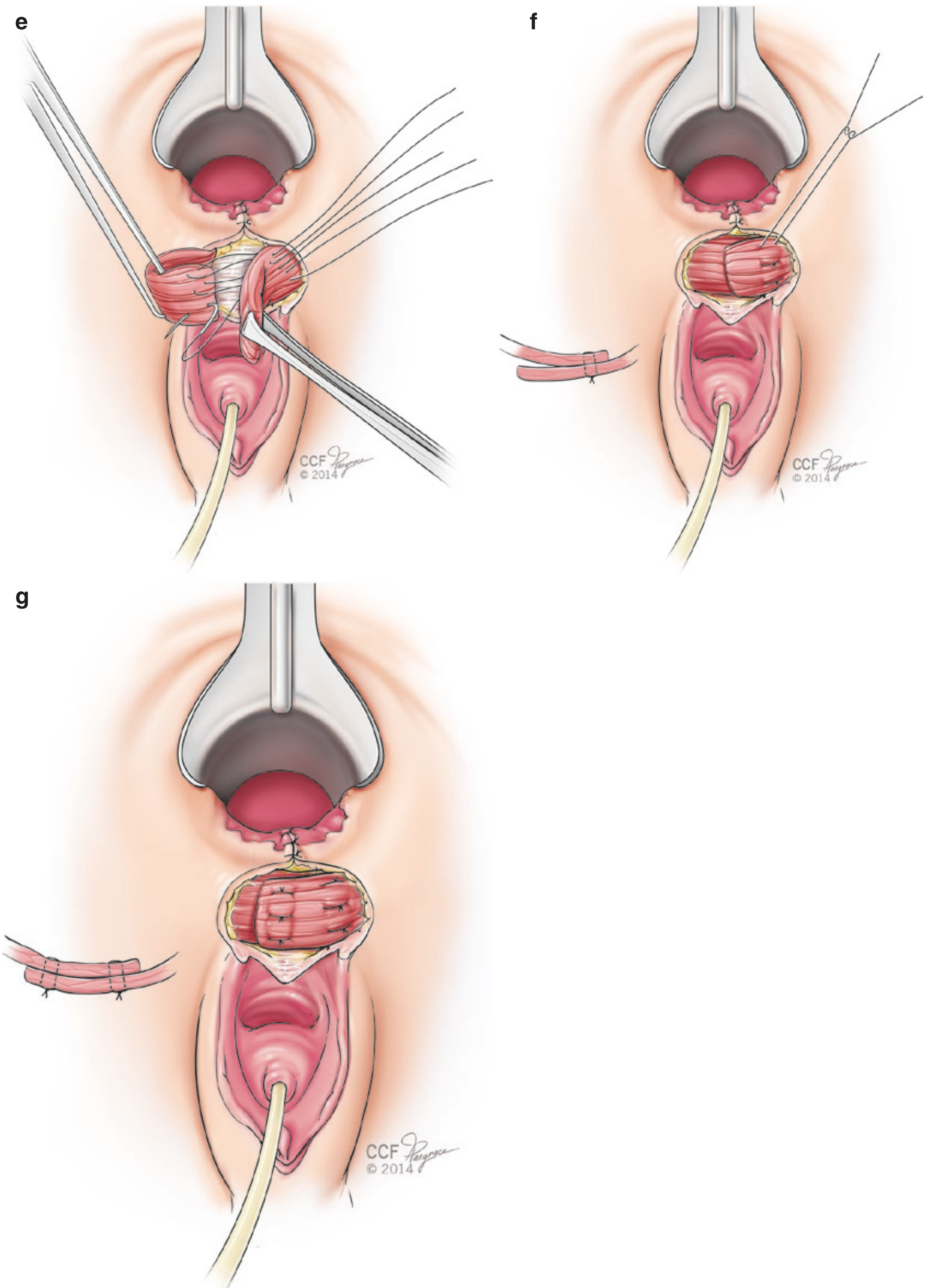

Fig. 14.3 (continued)

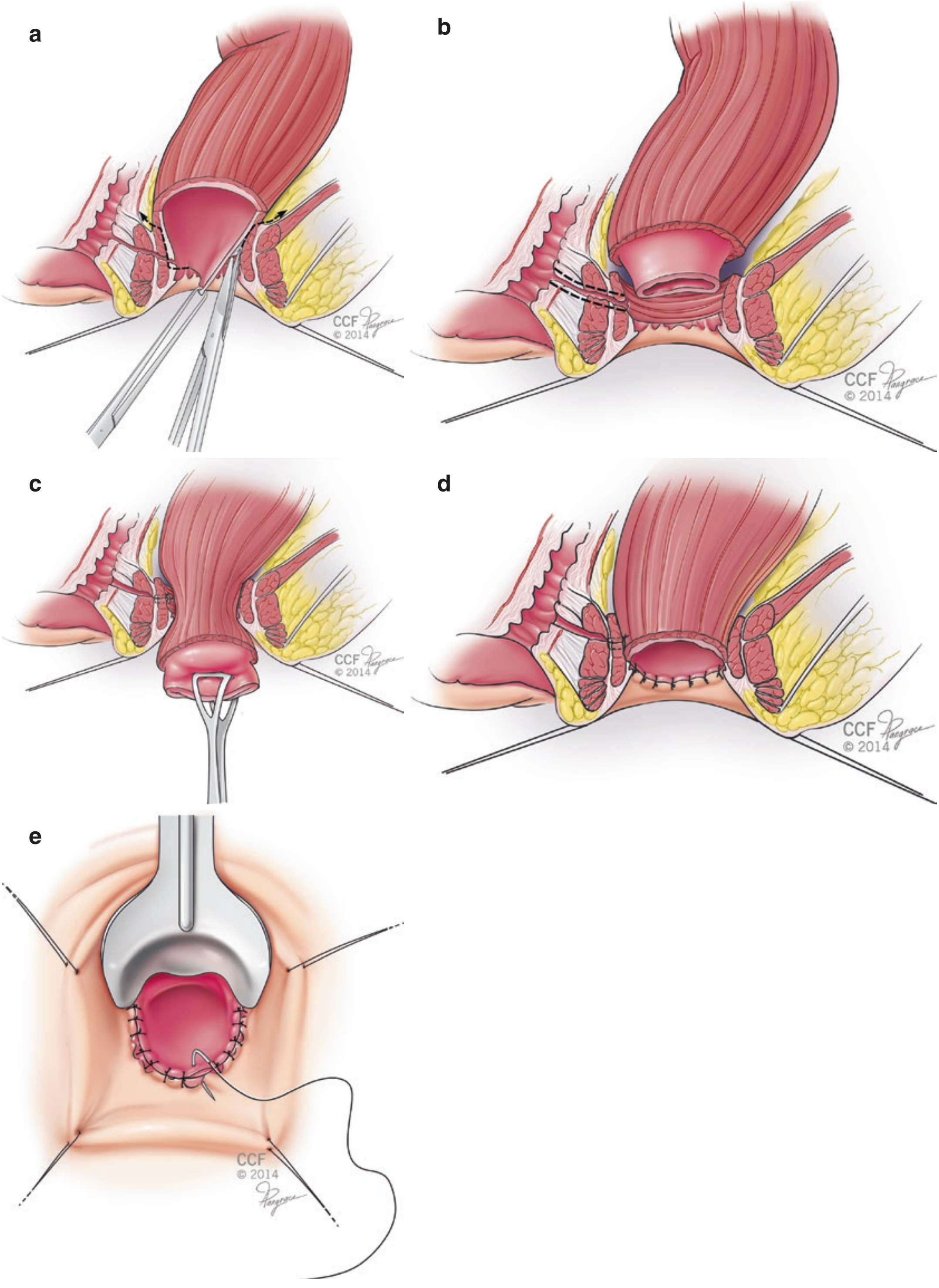

Fig. 14.4 Rectal sleeve advancement. (**a**, **b**) Full thickness circumferential flap is raised starting at the dentate line, heading cephalad until sufficient mobilization is attained. (**c**) The fistula tract is debrided, closed on the rectal side while vaginal mucosa is left open. (**d**, **e**) The distal flap is sutured to the new dentate line with interrupted absorbable suture (*Reprinted with permission, Cleveland Clinic Center for Medical Art and Photography © 2008–2016. All rights reserved*)

thickness ileal pouch advancement flaps are a reasonable choice. For higher fistulas, or where there is accompanying stricture, mobilization of the ileal pouch anastomosis and pouch advancement, sometimes accompanied by abdominal mobilization, is recommended (Fig. 14.5). This approach starts with anal eversion sutures to provide exposure. A circumferential incision is made at the dentate line, distal to the fistula and any accompanying stricture. The pouch is dissected circumferentially and cephalad, excising the mucosa from the internal sphincter into the supralevator space. The pouch is mobilized circumferentially to the extent that a healthy portion of pouch reaches beyond the anal verge to allow for a tension-free anastomosis. The distal pouch segment is excised of the fistula- and stricture-containing portion. A neoileoanal anastomosis is created with interrupted absorbable sutures. As stated previously, there can be difficulty mobilizing the pouch from a transanal approach and further mobilization through an abdominal incision may be required. In a last resort, a pouch excision with redo of the ileoanal pouch may be needed.

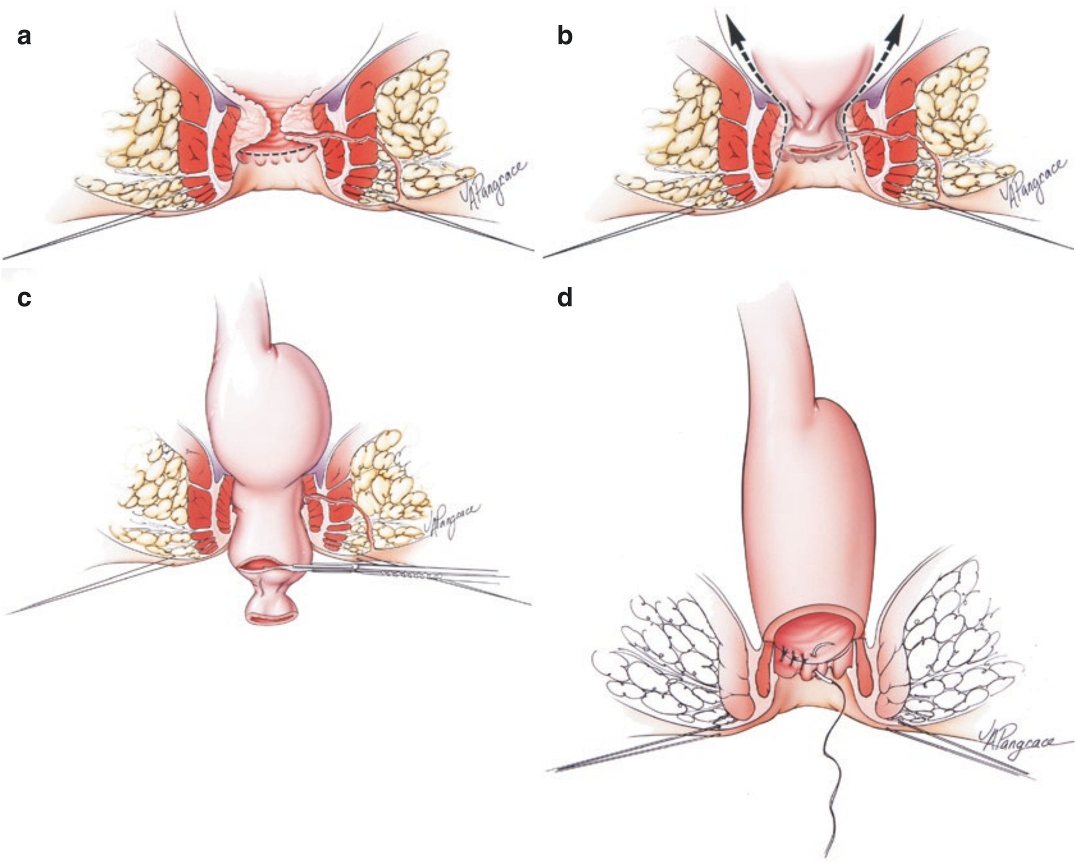

Fig. 14.5 Pouch advancement and neoileoanal anastomosis for pouch vaginal fistula. (**a**) Anal eversion sutures (or Lone Star retractor, neither shown) provide exposure. A circumferential incision is made at the dentate line, distal to the fistula and any stricture. (**b**) The dissection is carried circumferentially and cephalad into the supralevator space excising remaining mucosa and mobilizing the pouch-anal anastomosis. (**c**) The pouch is mobilized such that normal distal pouch reaches beyond the anal verge, and the fistula-containing portion is excised. (**d**) A tension-free neoileoanal anastomosis is created with interrupted absorbable sutures; if there is concern with reach, an abdominal mobilization is performed (*Reprinted with permission, Cleveland Clinic Center for Medical Art and Photography © 2008–2016. All rights reserved*)

Vaginal Approaches

Because the anorectum is the higher pressure side of the fistula, most in colorectal surgery prefer transrectal procedures. However, in settings where the rectum is inflamed or scarred, vaginal approaches have the benefit of the repair being done with healthy, pliable, and well vascularized tissue. Vaginal advancement flaps entail raising a flap around the fistula from the vaginal side. The rectal fistula opening is closed with absorbable suture. The levator ani muscles are approximated to form a barrier between rectum and vaginal walls, though this approximation may be difficult in very low fistulas and contribute to dyspareunia. The vaginal flap is trimmed to excise the portion containing the fistula opening, and the flap is then sewn to perineal skin with absorbable sutures. Another vaginal approach is fistula inversion, which can be used for low and small fistulas. A flap of vaginal mucosa is raised around the vaginal side of the fistula opening. A few concentric purse string sutures are placed, which invert the fistula into the rectum. The opening in the vaginal mucosa is then closed.

K. Tissue Interposition

In instances of multiple prior failed repairs or other etiologies leading to inadequate healthy tissue available for flaps, interposition of a flap of well vascularized tissue should be considered. Two of the more common procedures are gracilis interposition and bulbocavernosus ("Martius") flaps (Fig. 14.6). They offer the benefit of a perineal approach, thereby avoiding the morbidity that can accompany

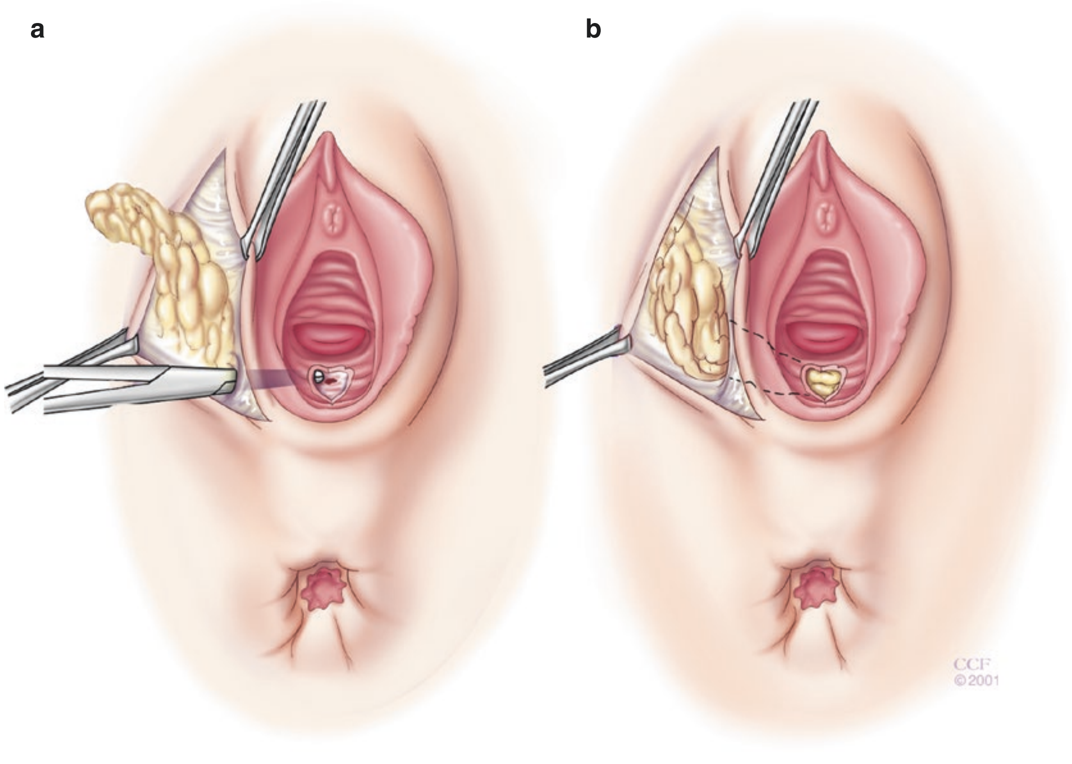

Fig. 14.6 Bulbocavernosus (Martius) graft. (**a**) (Not shown) Through a transverse perineal incision the posterior vagina is dissected from the rectum and the fistula is divided. The rectal fistula os is closed with absorbable suture. A longitudinal incision over either labia major is made. The fat pad and bulbocavernosus muscle are mobilized, preserving the vascular pedicle. The proximal attachments are divided. (**b**) A subcutaneous tunnel from labial to perineal wound is created and the graft is pulled through the tunnel ensuring appropriate orientation (no twist). The graft is loosely affixed above the rectal closure. The labial and perineal incisions are closed with interrupted absorbable suture, and a drain is typically used to prevent seroma (*Reprinted with permission, Cleveland Clinic Center for Medical Art and Photography © 2008–2016. All rights reserved*)

abdominal incisions, but are typically done with a diverting stoma in place. The procedural details will not be fully described here, but the approach requires complete muscle mobilization, division of the distal tendon near the knee, preservation of the proximal vascular pedicle, tunneling of the muscle into a space dissected between anorectum and vagina, and securing the flap in place. The rectal side of the fistula os should be repaired after debriding the edges, while the vaginal side can be left open to drain. The gracilis flap is useful since disruption of the muscle leads to little functional deficit, though morbidity from the leg incision can be a problem after this surgery. For any tissue interposition approach, an important portion of the perineal dissection is adequate dissection superior to the fistula. One should dissect at least 3–5 cm cephalad in the rectovaginal septum to separate the vaginal and anorectal openings.

Martius flaps (Fig. 14.6) require a transverse perineal incision through which the posterior vagina is dissected from the rectum and the fistula is divided. The rectal fistula os is closed with absorbable suture. Next, a longitudinal incision is made over either labia major. The fat pad and bulbocavernosus muscle are mobilized, with careful attention to preserving the vascular pedicle. The attachments proximally are divided. A subcutaneous tunnel from the labial incision to perineal incision is created and the graft is pulled through the tunnel ensuring the graft is not twisted. The graft is loosely sutured in place to separate the vaginal and anorectal opening. The labial and perineal incisions are closed with interrupted absorbable suture.

L. Redo Colo-anal Anastomosis, Immediate and Delayed

When local flaps and perineal approaches are no longer an option and in settings of severe circumferential disease, resection and anastomosis with an abdominal approach may be required. This can be done in one procedure if the dissection and anastomosis is far enough distal to the fistulous tracts, and is similar to the rectal sleeve advancement flap though with intra-abdominal mobilization as necessary. In some instances, though, the fistulas are multiple and/or low enough that they would be near the neodentate line. For these difficult cases, a Turnbull-Cutait procedure, or two stage colo-anal anastomosis, should be performed (Fig. 14.7). Via an abdominal incision, mobilization of the colon is performed from the splenic flexure down to the rectum. Dissection is carried down to the levator ani muscles. The rectum is divided. From the perineum, anal eversion sutures are placed for exposure and a mucosectomy is performed. A total of eight interrupted sutures are placed around the anal canal and the needles left on for the second stage anastomosis. These should be evenly spaced and incorporating a bit of internal sphincter. Using a Babcock, the colon is pulled through the anus. The distal edge of the exteriorized colon is transected to ensure adequate blood supply as confirmed by active bleeding. The colon is wrapped in gauze, the eight sutures and needles are carefully wrapped around this gauze and then covered with an additional gauze wrap to protect against inadvertent needle stick injury. The gauze is secured in place. If the patient is not already diverted, a loop ileostomy is created and the abdomen closed. At the second stage, generally performed five to seven days later to allow time for the bowel to adhere, the exteriorized segment is excised and the anastomosis is completed with full thickness sutures through the colon wall. Special care is taken to avoid anal canal mobilization, which would disrupt the adhesions between bowel and raw surface of fistula repair.

Conclusion

RVF are challenging both for the patient and the surgeon. As with most surgical conditions, the best opportunity for a successful outcome is with the first repair. A careful evaluation to understand the fistula etiology and anatomy, adequate control of sepsis, and a deliberate plan for surgical repair which considers the health of the surrounding tissue optimize chances for complete healing. Surgeons familiar with a range of techniques will be best suited to offer the procedure most likely to yield success.

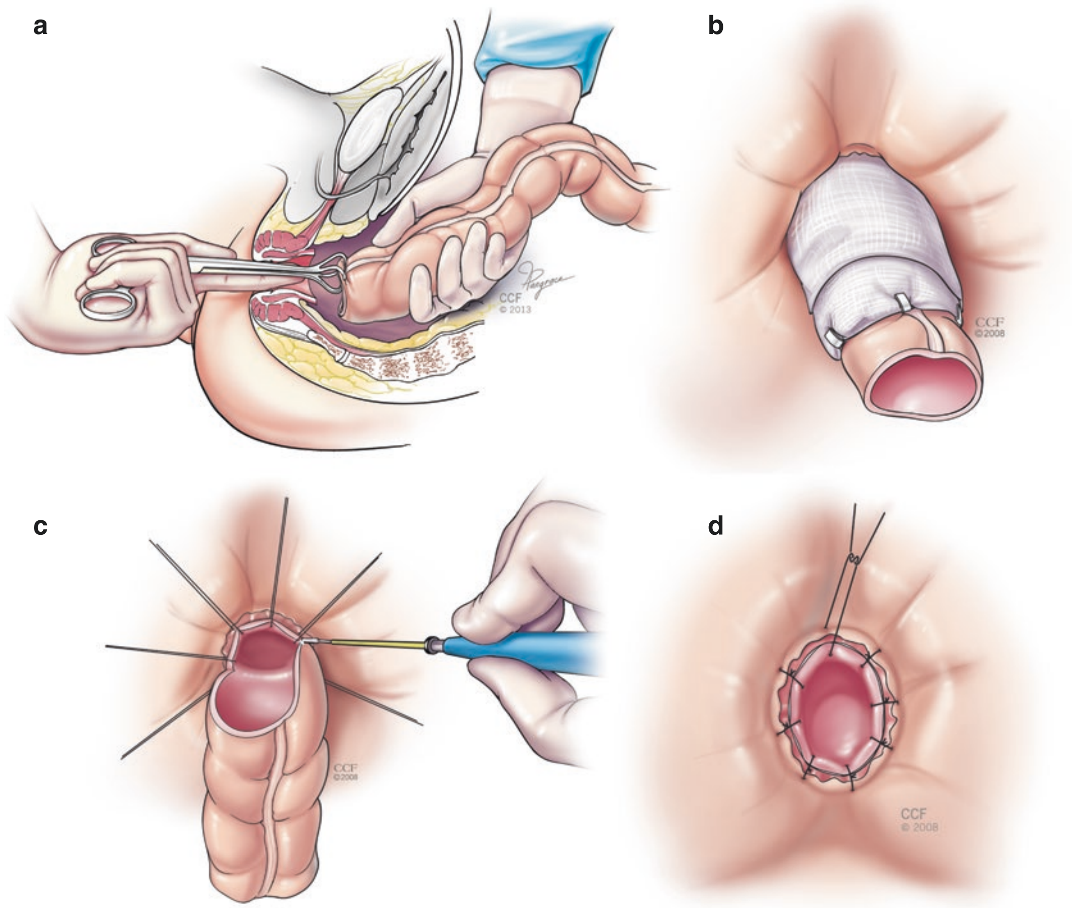

Fig. 14.7 Turnbull-Cutait abdominoperineal pull through. (**a**) After mucosectomy and mobilization with complete pelvic dissection to the levator ani, the colon is amputated and pulled through the anal canal. (**b**) Anal anastomotic sutures are placed (not shown) and wrapped around the exteriorized portion which is wrapped in Vaseline-moistened gauze. The entire colon with sutures is wrapped in a gauze and secured to keep the gauze from unwrapping. (**c**) Second stage, gauze is carefully unwrapped and the sutures laid out. The exteriorized segment is excised. (**d**) Using previously placed sutures, the anastomosis is completed through bowel wall, with care not to disrupt adhesions between the colon and anal canal (*Reprinted with permission, Cleveland Clinic Center for Medical Art and Photography © 2008–2016. All rights reserved*)

Suggested Reading

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15 Anal Conditions: Anorectal Crohn's Disease—Fistula

Andrew T. Schlussel and Karim Alavi

Introduction

Anorectal Crohn's disease (CD) may be observed in up to 90% of patients, with manifestations including skin tags, hemorrhoids, abscesses, and fistulas. The majority of these patients will require an operation. The degree of perianal disease often coincides with the patient's luminal disease, and inflammation located distally is often associated with a greater risk of perianal complications. The most common presentation of perianal CD, and often most challenging to treat, are anorectal fistulae and abscesses, which occur in approximately 50% and 42% of patients, respectively. The primary focus in the management of anorectal fistulae, regardless of the etiology is to prevent ongoing tissue destruction, and preserve sphincter integrity in efforts to maintain continence.

A cryptoglandular abscess or fistula may occur in CD, and should be treated as it would in a patient without CD. However, determining the underlying pathophysiology may often be a challenge. A true Crohn's disease associated fistula typically arises from a penetrating rectal ulcer or cryptitis that spreads into the intersphincteric planes. This results in an upregulated immune response in the fistula tract resulting in chronic recurring inflammation and remodeling. These factors alter the natural repair mechanisms of the body, and make the treatment of a Crohn's related fistula far more complex.

A single perianal fistula could be the index presentation of Crohn's disease, and this must be a differential diagnosis for all treating surgeons. A high index of suspicion is required for all complex or recurrent fistulas, those that fail to heal from a previous operation, ones with multiple tracts, or patients with associated symptoms secondary to proctitis. A thorough history and physical, which includes an endoscopic evaluation, is necessary prior to implementing an operative plan. Ultimately determining the diagnosis will be a multidisciplinary approach between the surgeon and gastroenterologist; however, it is on the surgeon to provide the safest operation with optimal means of sphincter preservation especially when the diagnosis is unclear.

Refer to Algorithm in Fig. 15.1

A. Septic presentations are the most common indication for surgical intervention in CD. These include an abscess or undrained fistula, and must be managed in an urgent

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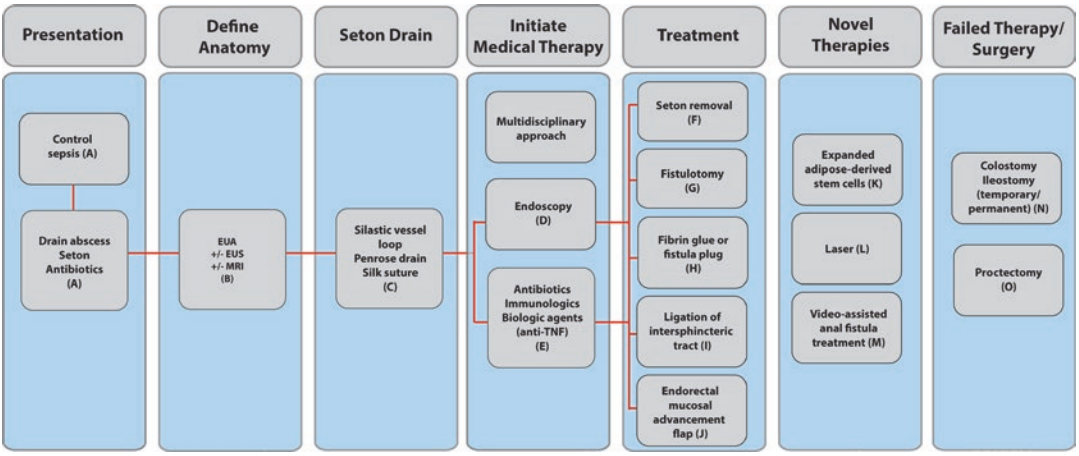

Fig. 15.1 Algorithm for management of an anorectal fistula in Crohn's disease. *EUA* examination under anesthesia, *EUS* endorectal ultrasound

Fig. 15.2 Example of seton placement. (**a**) Penrose drain for large fistula tract. (**b**) Silastic vessel loop for narrow tract

fashion to prevent systemic complications. Special considerations should be made for a CD patient when performing an incision and drainage for a perianal abscess. The incision should be as close to the anal verge as possible, but still provide appropriate drainage. This may minimize the length of a fistula tract if one is to develop in the future. In addition, a drainage catheter may also be placed in a large cavity, allowing it to close around the tube over time, and if there is a concomitant fistula at the time of presentation a draining seton should be placed using either a silastic vessel loop or Penrose drain (Fig. 15.2).

B. Successful management of a fistula is dependent on accurately defining its anatomy and characterizing the degree of sphincter involvement. The epithelialized tract of an anorectal fistula connects the anal crypts at the dentate line to an external opening on the perianal skin, and typically corresponds to a previous abscess drainage site. Classification of an anorectal fistula is defined based on its relationship to the sphincter complex and includes: intersphincteric, transsphincteric (low or high), suprasphincteric, or extrasphincteric (Fig. 15.3). To simplify the management of perianal fistulizing disease, the American Gastroenterology Association

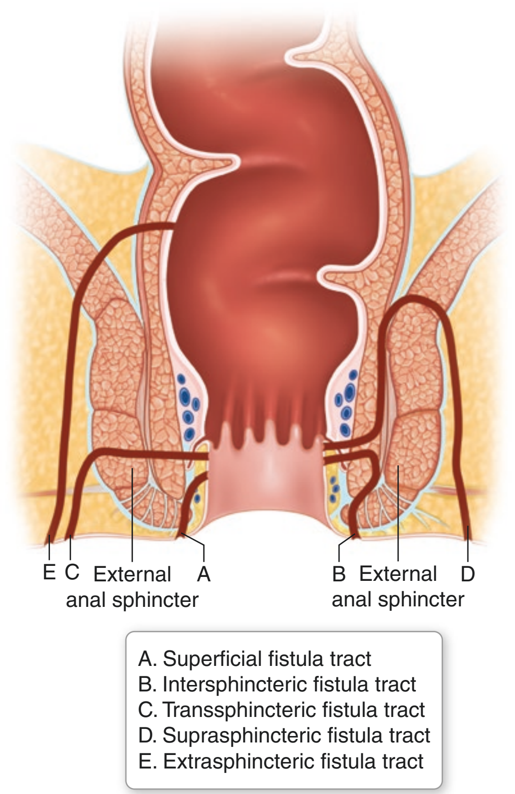

Fig. 15.3 Classification of anal fistulae (AGA Technical Review on Perianal Crohn's disease)

(AGA) dichotomized the disease into two groups, "simple" and "complex," fistulas. Simple fistulas are distal, below the dentate line, with a single external opening and no associated fluid collections or perianal complications. These fistulas may be termed superficial or low intersphincteric, or low transsphincteric. Complex fistulas are proximal to the dentate line, there may be multiple external openings (Fig. 15.4), and an associated abscess or other perianal disease may be present. These fistulas can be classified as high intersphincteric, high transsphincteric, extrasphincteric or suprasphincteric. From another perspective, all fistulas in patients with CD are complex due to the underlying immune suppression associated with CD. A perianal Crohn's disease score can also be used to help make therapeutic decisions and to monitor disease status.

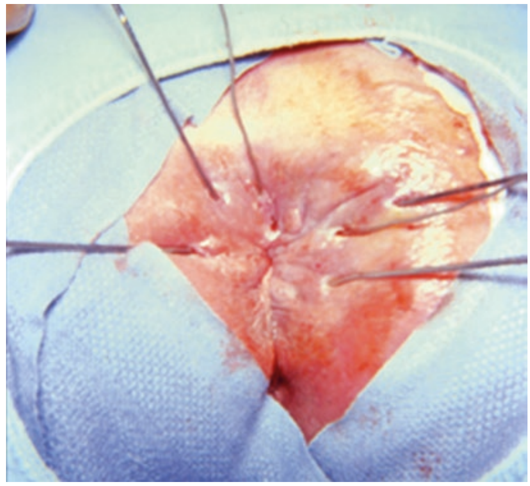

Fig. 15.4 Complex anorectal fistula with multiple external opening. Metallic probe localizes external fistula openings

An exam under anesthesia (EUA) is usually required to fully characterize the extent of disease (Fig. 15.5). Additionally, an endoanal ultrasound (EUS) or magnetic resonance image (MRI) may be used to aid in operative planning. EUS has been associated with a sensitivity and specificity of 87% and 43%, respectively, in the detection of a fistula tract. The instillation of hydrogen peroxide in the fistula will also enhance the tract and improve identification. However, tenderness may preclude interanal ultrasonography. Pelvic MRI has recently been reported as the gold standard in the diagnosis of perianal CD. Sofic and colleagues demonstrated that MRI had an accuracy of 100% when discriminating between intersphincteric, transsphincteric, suprasphincteric and extrasphincteric fistula tracts. In addition, MRI has a sensitivity and specificity of 87% and 69%, respectively, in its ability to characterize the anatomy of the fistula tract through each muscle layer of the sphincter complex. MRI will also aid in the identification of any undrained fluid collections and differentiate active inflammation from chronic fibrosis. In a direct comparison of EUS and MRI, Schwartz *et al*. demonstrated that when either imaging

Fig. 15.5 (**a**, **b**) Exam under anesthesia of complex anorectal fistulae in Crohn's disease

technique was combined with a thorough exam under anesthesia, the accuracy of defining fistula anatomy was 100%.

C. The standard in management of an anorectal fistula in the setting of CD is seton placement. Drains are typically in place prior to the initiation of medical management, and are often placed even before the diagnosis of CD is made. The utilization of a silastic loop or suture through the tract allows for adequate drainage of the fistula, which prevents further septic complications, promotes epithelialization, and provides the necessary means to treat this process in a staged fashion. There is no limit to the duration of time a seton drain can remain in place. However, despite the benefits, fistula closure is not possible while the drain is in place. In certain cases, this could function as a definitive treatment strategy, or provide time for medical therapy to take effect. Seton removal alone is associated with a 33–70% risk of a recurrent or persistent disease. In addition, leaving a seton in place indefinitely, or not treating the fistula tract has a low but potential risk of malignant degeneration. In a recent systematic review by Thomas *et al.,* a total of 61 cases, from 34 separate studies, identified a carcinoma arising from in an anorectal fistula tract. These fistulas most commonly originated from the rectum (59%), with 41% developing from the perineum or anus. Histologically, adenocarcinoma was identified in 59% of cases, followed by squamous cell carcinoma in in 31%. Therefore, a strong consideration for an additional procedure to address the fistula tract is advised.

D. Prior to initiating treatment, a full endoscopic exam should be performed to further delineate any proximal luminal disease. Surgical intervention, short of drainage procedures, should be approached with caution if active proctitis is present.

E. Management strategies require a multidisciplinary approach and are divided into medical (antibiotic, immunologic, and biologic therapy) and surgical. Antibiotics are typically considered first line therapy when treating the initial infectious process. Ciprofloxacin and metronidazole have been considered as drugs of choice.

F. In the era of biologic therapy, particularly anti-tumor necrosis factor (TNF) agents, seton removal following effective medical management may be considered. Present and colleagues in 1999 described the administration of infliximab, an anti-TNFα antibody, for the treatment fistulas in CD, and results demonstrated complete closure in 46% of

patients. Authors evaluated both perianal and abdominal fistulas, however, 90% of the study population consisted of those with anorectal disease. Kotze and colleagues demonstrated a remission rate of 53% seton placement was combined with infliximab. Further studies have supported seton removal alone as a definitive treatment strategy following multimodal therapy. If this approach is considered, the patient should be treated with a minimum of three infliximab infusions, and there should be no evidence of persistent of active proximal inflammation.

G. Operative interventions depend on disease complexity, and may be as simple as a fistulotomy, or aggressive as a proctectomy. Due to the high risk of recurrence of anorectal CD, performing a standard lay open fistulotomy should be reserved in cases of a low-lying simple fistula, with no evidence of active proctitis. Delayed wound healing is not uncommon, for up to six months following surgery. In the appropriately selected patient the risk of fecal incontinence is minimal. If there is additional concern for the degree of sphincter muscle involvement, a partial fistulotomy, opening the perianal skin to the level of the external sphincter, and simultaneous seton placement is a suitable option. Furthermore, if the patient is asymptomatic, with a low fistula, observation may be the best strategy.

H. Surgical options that have minimal to no effect on sphincter function include the injection of fibrin glue or the placement of a fistula plug. Although the recurrence rate may be as high as 41% and 12% for glue and fistula plug respectively, these procedures have no risk of incontinence and should be considered in CD patients with complex fistula tracts. The key steps in insertion of the fistula plug are to first ensure all perianal sepsis is resolved, and no active abscess remains. The fistula plug is suitable for a long external tract to allow the plug to be seated appropriately in position. Furthermore, the internal opening must be identified to either suture the proximal portion of the fistula plug to the mucosa, or the mucosa must be closed over the prosthesis, promoting incorporation of the biosynthetic material and ultimate closure of the fistula.

I. The ligation of the intersphincteric tract (LIFT) procedure has been recently introduced as a successful treatment option for a complex transsphincteric fistula. This operation is performed within the intersphincteric space, and involves division of the fistula tract in efforts to preserve continence without injury to the sphincter muscles. Success of this operation requires a well-epithelized tract, and is often performed as a second stage operation following placement of a draining seton. Adequate effacement of the anus is necessary, providing a means the clearly identify the internal and external sphincter complex. A transverse incision is made over the intersphincteric groove, and careful dissection is carried proximally into the intersphincteric space, localizing the fistula tract. Placing a probe through the tract may aid in the dissection. Once identified, the fistula tract is encircled, clamped proximally and distally, sharply divided, partially resected, if feasible, and suture ligated (Fig. 15.6). The tract should be probed from the internal and external openings to ensure it is securely closed, as this will minimize the risk of recurrence. The internal opening is then closed, and the external segment of the tract is debrided. The incision is closed loosely in a transverse fashion. This operation is associated with complete fistula closer in >60% of cases following twelve months, however, there is a paucity of data regarding the long term results of the LIFT procedure in CD. Gingold and colleagues more specifically reported that the LIFT was successful in 60% of patients with CD at two months with no evidence of fecal incontinence; 12 months after surgery, 33% of patients were fistula free. Recurrence typically presents with drainage at the incision over the intersphincteric space. Generally, the recurrent or persistent fistula has been converted from a transsphincteric to an intersphincteric fistula, and this may be managed with a

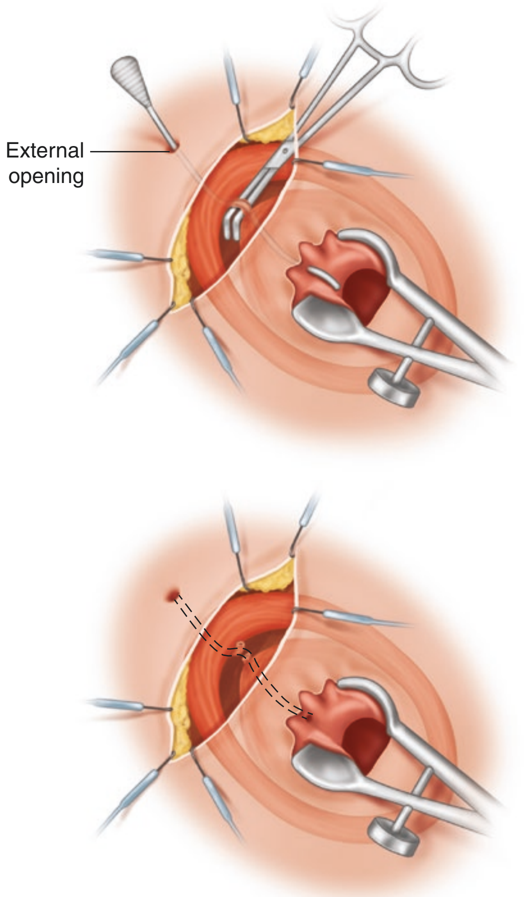

Fig. 15.6 Ligation of intersphincteric fistula tract

simple fistulotomy if the tract is low. However, seton drainage always remains an option regardless of the fistula's anatomy.

J. Endorectal advancement flap is one option to treat complex fistulizing disease in patients without evidence of proctitis. This technique involves mobilizing a proximal healthy full or partial thickness rhomboid or U-shaped flap of rectal wall to cover and close the internal fistula opening (Fig. 15.7). The base of the flap should be twice as wide as the apex to ensure adequate blood supply, and flap length is determined by the size of the defect requiring coverage. The tract should be thoroughly debrided and then closed prior coverage by the flap. The external opening should be widely debrided and opened up to the edge of the sphincter complex to prevent abscess recurrence. The editor's (SDW) preference is to utilize an elliptical flap without corners. Physiologically, by covering the internal opening, this disrupts the flow of feces and bacterial contents into the fistula tract allowing the external segment to obliterate and close. This technique is better suited for cases of anal fistulae located in the upper two-thirds of the sphincter complex. In a systematic review by Soltani, the reported rate of success was 64%, with a risk of incontinence of 9.4% in cases of CD. A proximal diverting stoma may also be considered depending on the extent of repair and the number and type(s) of prior repair(s). When possible any proximal disease should be treated prior to attempted flap construction. Unfortunately, only 47% of patients requiring temporary fecal diversion are able to achieve successful fistula closure, and subsequent restoration of intestinal continuity. These patients should be strongly counseled on the aggressive nature of their disease, and sphincter function should be evaluated objectively prior to the consideration of stoma reversal.

K. Due to the aggressive nature of Crohn's related fistulas, high rate of recurrence, subsequent risk of fecal incontinence, and effect on quality of life, innovative approaches in the treatment of this disease process have been popularized. In efforts to promote tissue regeneration and repair, expanded adipose-derived stem cells (ASCs) have been introduced. This substance is thought to suppress inflammation while having the potential to differentiate into native cells to allow for the fistula tract to seal. The ASCs are harvested from lipoaspirated fat cells that are resuspended in human albumin. The cellular matrix is injected through a long needed directly into the fistula tract and then sealed with fibrin glue. Phase III trials evaluating this therapy identified a higher rate of fistula closure at twelve weeks when ASCs were combined with fibrin glue compared to fibrin glue alone; however, no significant difference

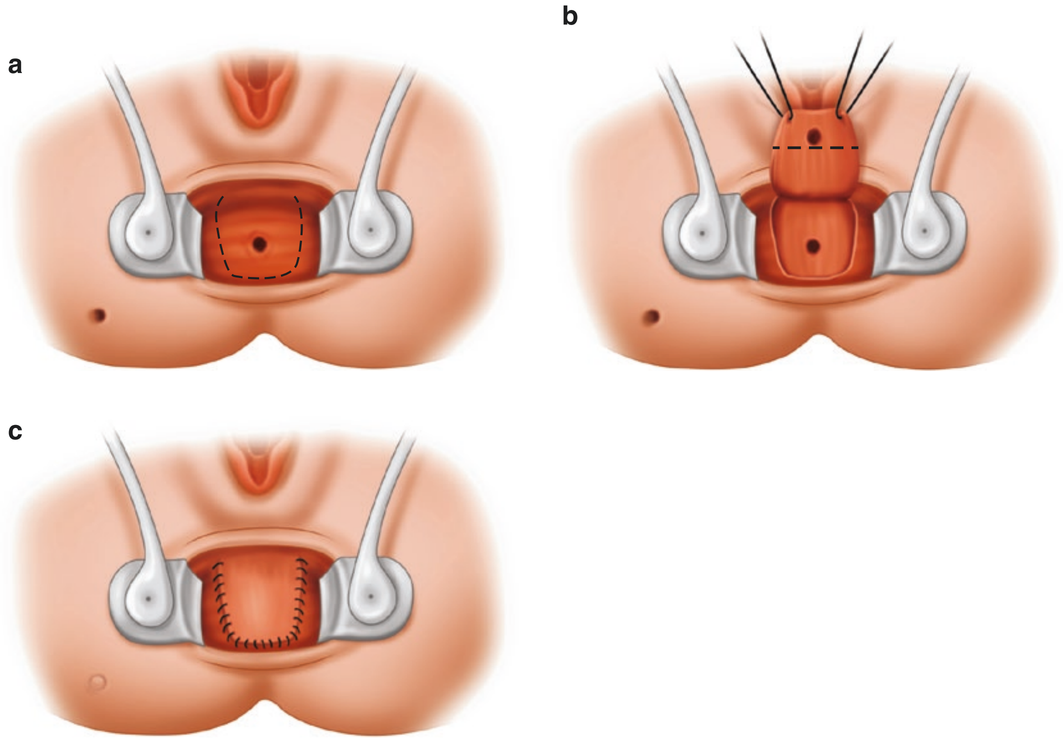

Fig. 15.7 (**a**) Healthy full or partial thickness rhomboid or U-shaped flap of rectal wall to cover and close the internal fistula opening. (**b**) Excise the tip of the flap containing the fistula tract. (**c**) After debriding and closing the tract, suture the flap to cover the internal opening

was found at 24–26 weeks postoperatively. The authors concluded that additional investigations are required to further elucidate the optimal use for ASC therapy.

L. To focus on managing persistent fistula tracts due to remaining fistula epithelium and granulation tissue Wilhelm in 2011 developed a novel technique using a radially emitting diode laser probe to seal the fistula tract. The safety of this technique has been validated in Crohn's related fistulas, and has been studied in cases of mid or high trans-sphincteric fistulas and anterior intersphincteric or low transsphincteric fistulas in woman with some degree of fecal incontinence. This approach was initially described as a technique to be performed in conjunction with an endorectal advancement flap to close the internal opening; however, a more recent study has demonstrated a success rate of over 70% when the laser was used alone. Fistula tract ablation with the diode laser has recently been approved for use in the US but must be used with caution in the setting of Crohn's perianal disease.

M. Applying similar fundamental principle to laser therapy, Meinero and colleagues introduced the video-assisted anal fistula treatment (VAAFT) in 2014. This technique involves inserting a fistuloscope into the external opening, identifying the internal opening and applying therapeutic interventions. Direct visualizing allows the identification of secondary tracts and undrained abscess cavities. Once the tract is fully characterized a unipolar electrode is placed within the fistuloscope, it is slowly retracted cauterizing the fistula walls under direct visualization. The authors reported that following six months the rate of fistula closure was 70% based on a Kaplan-Meier analysis. This technique has been demonstrated to be a

safe and feasible option in the treatment of complex perianal CD.

N. Despite the advancements in medical therapy and surgical techniques patients with moderate to severe CD may still require a colostomy or an ileostomy. Patients with fulminant disease may ultimately require a proctectomy. Temporary or permanent diversion has been reported at rates of 20%, and a strong multidisciplinary approach to the treatment of anorectal CD can aid in avoiding this operation. Typically, fecal diversion is reserved for cases of chronic perianal CD refractive to medical therapy, where systemic medications may be used in addition to minimize the incidence of recurrent disease. In addition, fecal diversion should be considered in cases of fecal incontinence secondary to disease progression or as the result of multiple fistula operations. Kasperek et al. even reported an improved quality of life in regards to bowel function when diverted patients were compared to those with active severe perianal Crohn's.

O. Proctectomy, or proctocolectomy based on the degree of luminal involvement, should be reserved for cases of anal CD where localized sepsis cannot be controlled with either medical or surgical interventions, anal disease so extensive a local surgery is precluded, poor quality of life due to persistent incontinence despite diversion, and inability to continue chronic wound care. Despite removal of all disease with an abdominoperineal resection, these patients will have difficulty healing a perineal wound, and the surgeon should consider myocutaneous flap coverage in the appropriate setting.

Conclusion

Perianal CD is a complex and challenging entity to treat. The principles in management includes correctly identifying and closing the internal opening, while fully characterizing the anatomy in efforts to obliterate and close all fistula tracts and remaining abscess cavities. With a variable number of presentations, the medical and surgical treatment must be individualized to minimize morbidity while preventing recurrence and incontinence. Given these challenges long-term non-cutting seton drainage combined with medical therapy may be the most realistic option.

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16 Anorectal Crohn's Disease: Anal Stenosis and Anal Fissure

Jeanette Zhang and Howard M. Ross

Refer to Algorithm in Fig. 16.1

A. Anal strictures with fibrotic induration have been shown to develop in up to 50% of patients with Crohn's disease (CD) with anal ulceration. These become clinically significant in about 5% of those with perianal CD. Strictures often are asymptomatic or produce minimal symptoms due to reduced stool consistency in CD. When symptoms do occur, they can include overflow diarrhea, perineal pain, constipation and/or fecal incontinence. Dilation can be achieved in many ways: digital, with dilators, or balloon dilation; each option will be discussed in this chapter. The latter method has become the choice for many, entailing a considerable long-term cost. A perianal Crohn's disease scoring system can be useful to help decide upon therapeutic alternatives and to monitor disease status.

B. The extent of perianal, intestinal and colonic disease are chief considerations prior to pursuing dilation. We generally start with a thorough examination under anesthesia to evaluate the extent of perianal disease and characteristics of the stricture. Computerized tomographic enterography and magnetic resonance imaging are important modalities to evaluate the extent of intestinal and colonic disease. In addition, appropriate endoscopic surveillance/evaluation should be performed in all patients with Crohn's, as the risk of malignancy both at the site of stricture and more proximal are higher than in the general population.

C. Fecal continence must always be considered. Baseline fecal incontinence and extensive perianal disease might be more satisfactorily addressed with combinations of resection and diversion. Biopsy of strictures, ulcers and chronic fistulae is recommended to exclude malignancy, though this is rare.

D. Interestingly, there are no published guidelines or standards regarding Crohn's anal stricture dilation. In a retrospective study by Linares *et al.*, patients with anorectal strictures underwent anal dilatation, which was performed by gentle digital examination in the majority of patients or by coaxial balloon technique in a few patients. In ~70% of cases, one or two dilatations were sufficient to improve symptoms related to anal stricture. Dilatation should be cautiously performed owing to the risk of sepsis. The authors reported subsequent abscess and fistulas in 18% (6/33) of patients,

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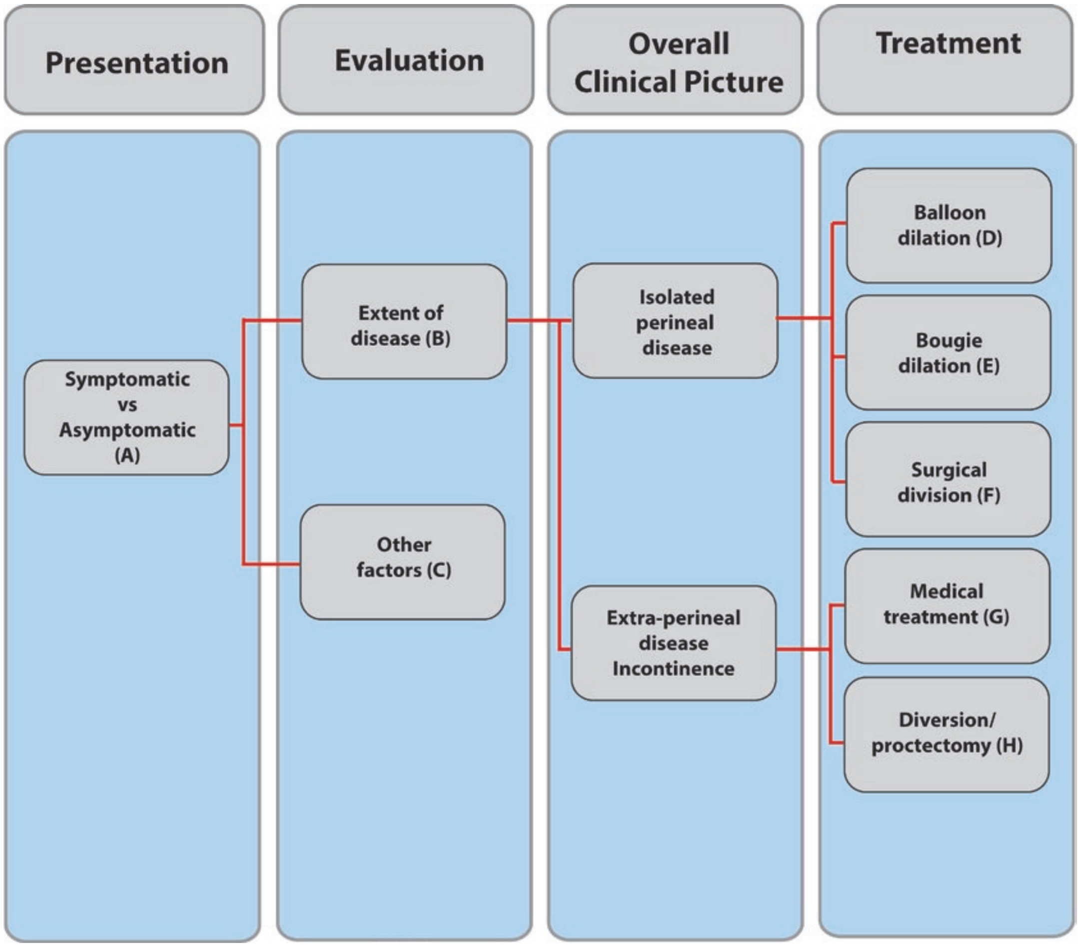

Fig. 16.1 Algorithm for anal stricture

with this risk being increased in the event of severe proctitis or associated sepsis during the surgery. Thus, an anorectal stricture cannot be dilated in the presence of severe anal disease or proctitis. Medical treatment is recommended in such patients.

E. A recent study from a single university teaching hospital demonstrated the technical feasibility, safety, long-term efficacy and cost-effectiveness of bougie dilation of CD anal strictures. Ten patients with symptomatic strictures underwent serial dilation with silicone bougies, undergoing as few as 14 to as many as 106 procedures. All patients in their sample reported immediate symptom improvement and noted increased treatment interval over the course of follow up, though 6 were still undergoing periodic dilations at time of publication. The authors determined bougie dilation to be a cost-effective manner of improving symptoms and, perhaps more importantly, of avoiding the need for surgical division of strictures and its associated complications.

F. Surgical division of short fibrotic strictures that are recalcitrant to dilation can be employed. Both open and endoscopic techniques are appropriate to divide the stricture from proximal to distal in a direction parallel to the length of the bowel. Lee and colleagues described an intriguing Heineke–Mikulicz technique in a small number of patients (6). In their recently published work, 7 patients with anorectal Crohn's disease underwent transanal rectal stricturoplasty using a

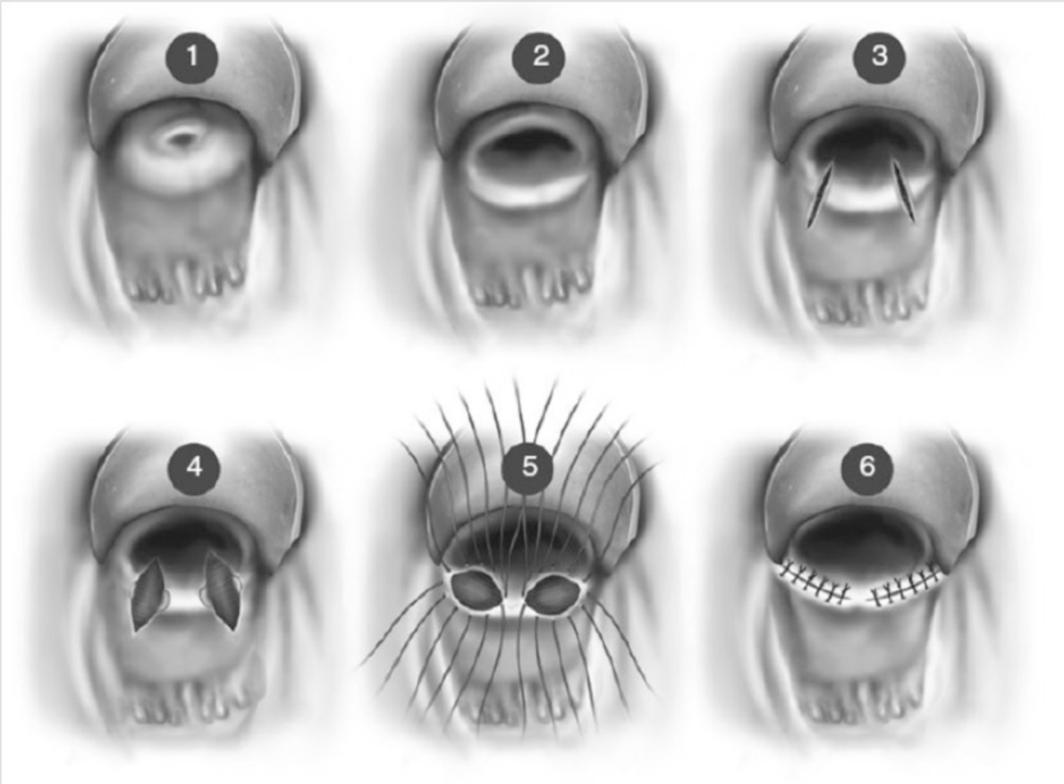

Fig. 16.2 Transanal rectal stricturoplasty. (With permission from Lee SW, Niec R, Melnitchouk, Samdani T. Transanal anorectal stricturoplasty using the Heineke–Mikulicz principle: a novel technique. Colorectal Disease 2016;18:101–5 © John Wiley and Sons)

Heineke–Mikulicz type stricturoplasty (Fig. 16.2) and found it a simple and effective treatment of with low morbidity.

G. In the presence of extensive perianal disease, treatment should focus on control of infection and medical optimization rather than dilation or surgical intervention. Similarly, addressing anal disease in the context of extensive intestinal or colonic disease may not be the most appropriate manner to help the patient.

H. Patients with extensive stricture should be periodically re-examined both to ensure that there is adequate patency, as well as to look for a potential malignant growth, with case reports of squamous cell and adenocarcinoma arising in perianal Crohn's disease. Despite all medical therapy and non-operative treatment, a small percentage of patients may require permanent diversion or even proctectomy.

Refer to Algorithm in Fig. 16.3

A. Anal fissures most commonly present with pain, though patients may also experience discharge, pruritus and bleeding. Similar to the general population, they are most commonly located in the posterior midline. However, fissures in CD are more likely than in the general population to be eccentrically located, with 9–20% located away from the midline. Fissures are also more likely to have atypical appearance and can cause deep ulcerations. The edges of such lesions are edematous and irregu-

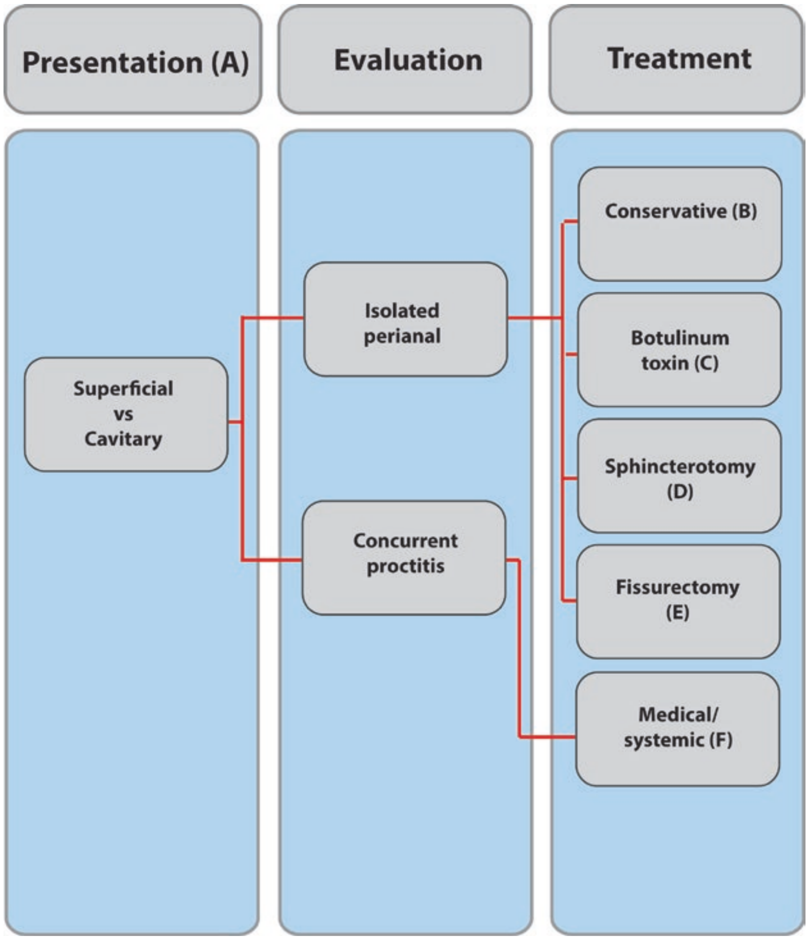

Fig. 16.3 Algorithm for anal fissure

lar, and patients present with severe, unremitting pain. These cavitating ulcers can be highly associated with concomitant proctitis.

B. The majority of fissures will heal with conservative management. Medical treatments are recommended first-line therapy. Available topical treatments include topical nitrates and calcium channel blockers. Topical nitrates have been shown in the general population to produce healing rates superior to placebo. Insufficient data is available on healing rates with topical calcium channel blockers, though they tend to produce fewer adverse effects than nitrates. Topical treatments may produce symptom improvement, although some authors suggest that alone they may not adequately induce healing, though others have found these to be successful in a majority of patients.

C. Botulinum toxin injection is another alterative available with healing rates superior to placebo. There are no uniform guidelines on dosage or location of injection. Dilation of the sphincter should be avoided as this can lead to suboptimal healing from uncontrolled trauma to diseased anal mucosa.

D. Surgical treatment can be effective in well-selected patients with Crohn's disease with anal fissures refractory to medical management. Lateral internal sphincterotomy (LIS) has been shown to produce high rates of healing of fissures in patients without active luminal disease; open and closed techniques yield similar results. Traditionally, LIS is performed to the level of the dentate. Other approaches

involve tailoring to the characteristics of the fissure. Smaller wounds that minimize damage to the mucosa and external sphincter are beneficial in this population where wound healing tends to be problematic.

E. Fissurectomy may be needed if edges of the fissure are fibrotic, as these are not likely to heal on their own. However, there are complications associated with operative management, even in well-selected patients. In their review of 41 patients with CD and anal fissure, Sileri et al. found 14 failed conservative management and required either Botox with or without fissurectomy or LIS. Eight of those 14 patients had complications including non-healing wound, recurrence, and one trans-sphincteric fistula. In a retrospective study by Fleshner et al., 8 of 46 patients with anorectal Crohn's fissure were managed surgically: three had LIS, two had fissurectomy, and three underwent both sphincterotomy and fissurectomy. At short-term evaluation, seven patients had a healed fissure and the one with no fissure healing underwent LIS. After a median follow-up of 92 months, one patient developed an abscess arising from the base of the non-healed fissure and two required proctectomy primarily because of persistent anorectal sepsis originating from the site of the fissure.

F. The tradition of avoiding surgery for anal fissures in CD still holds. As with luminal disease, it is reasonable to intervene on perianal manifestations as complications dictate. Caution should be used when pursuing surgical treatment of fissures in CD as there is a real risk of poor healing and the development of abscess or incontinence postoperatively. Concurrent proctitis must be ruled out and invasive procedures avoided if present, and sphincter preservation is critical. Systemic therapy with infliximab has been shown to produce and maintain complete clinical response of perianal CD. This effect is seen in both superficial fissures and cavitating ulcers. Despite the risk of complications, surgical intervention should not be avoided all together as up to 20–25% of fissures managed with medical therapy alone will progress to fistula or abscess.

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Management of Internal Hemorrhoids

17

Allison Weaver and Scott R. Steele

Refer to Algorithm in Fig. 17.1

A. Initial evaluation of hemorrhoids should focus on observation of the perianal area and eliminating more serious etiologies. Many patients will present with painless, bright-red rectal bleeding, and occasionally with prolapsing tissue. Colonoscopy or flexible sigmoidoscopy is appropriate especially in older patients, to exclude malignant causes even if hemorrhoids are visualized. If bleeding is significant, performing a CBC may be necessary to allow for identification and treatment of blood-loss anemia. Further assessment of the hemorrhoids with digital exam, anoscopy, and fecal occult blood test will provide more information on size, fluctuance, and overall sphincter tone. If the patient is asymptomatic, no further evaluation or treatment is necessary although lifestyle modifications may be recommended to prevent progression.

B. Grading of internal hemorrhoids is based on the protrusion of the hemorrhoid through the anal sphincter. Grade I describes hemorrhoids that may bleed, but do not prolapse. Grade II prolapse with defecation but immediately retract. Grade III prolapse and require manual reduction. Grade IV prolapse and are not able to be manually reduced. Both grade III and IV may become acutely strangulated if blood flow is compromised. Treatment of internal hemorrhoids grades I–III traditionally follows a least-to-most invasive approach, beginning with lifestyle modifications and progressing stepwise to surgery if earlier interventions fail to improve symptoms. Grade IV or any acutely strangulated hemorrhoid generally requires semi-urgent or emergent hemorrhoidectomy.

C. Lifestyle modification is the first-line treatment of low grade hemorrhoids and in conjunction with surgery for grade IV. Alterations should focus on diet and bowel habits that can cause constipation or hardening of stool, as these problems are associated with hemorrhoid development and exacerbation. Fiber is inexpensive and effective and can be added into the diet or taken as a supplement. Increasing fiber intake is one of the easiest alterations to make and has shown to reduce symptoms and may prevent the need for subsequent surgery. It is important to also drink sufficient quantities of water/fluids with the fiber to avoid paradoxical constipation. Straining and increased time spent on the toilet are also behaviours that are contributory and should be discouraged. Warm water baths may also alleviate symptoms and, because of the low

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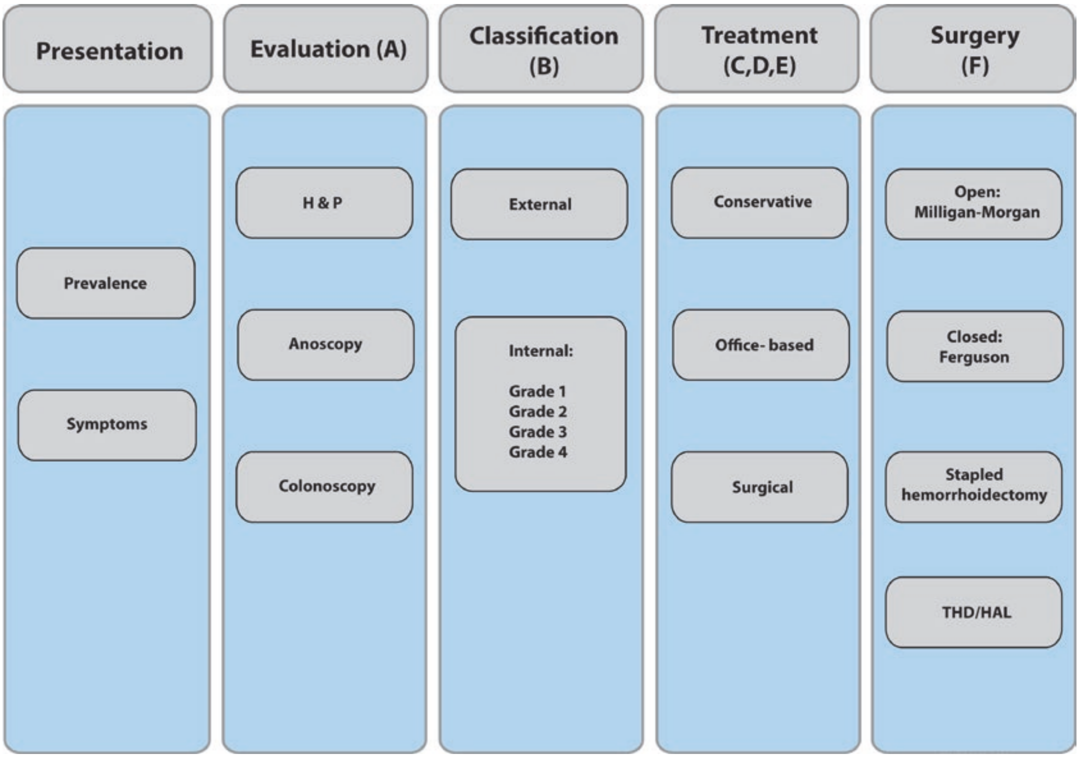

Fig. 17.1 Algorithm for evaluation and management of internal hemorrhoids. *H & P* history and physical examination, *THD/HAL* transanal hemorrhoidal dearterialization/hemorrhoidal artery ligation

cost and ease of availability, can be recommended. Counseling patients and encouraging these changes will resolve or manage the symptoms in many individuals and may avoid further escalation of treatment.

D. Medications to manage internal hemorrhoids are generally oral or topical preparations that provide mainly symptomatic relief. Phlebotonics such as oral flavonoids and calcium dobesilate are venotonics that increase venous tone and lymphatic drainage and decrease capillary permeability, but it is not entirely clear how these characteristics aid in hemorrhoidal treatment. Nevertheless, phlebotonics have been shown to aid in symptomatic improvement, including bleeding, persistent pain, itching, and recurrence. However, the body of evidence supporting their use is somewhat limited and methodologically questionable, necessitating further study to substantiate their effects. Most creams currently on the market have been poorly studied and therefore their clinical efficacy is largely unknown. Preparation H® (Pfizer, Kings Mountain, NC) and similar popular creams are available in different formulations that generally have some vasoactive properties, but the overall mechanism of treatment or symptomatic relief, if present, is unknown. Topical steroids are often used and definitely have a role in symptomatic relief. Their long-term use is limited and has the usual atrophic effects, although they can be extremely useful in situations where invasive procedures are best avoided such as pregnancy. Isosorbide dinitrate is effective in decreasing internal anal sphincter tone, but there is limited evidence for its use in treating most hemorrhoids outside of acutely strangulated internal hemorrhoids. Overall, medications may offer symptomatic relief that can prevent or delay the need for more invasive procedures.

E. Office procedures should be offered as non-operative management for all hemorrhoids refractive to more conservative treatment and even grade III hemorrhoids that aren't acutely strangulated. The major issues in hemorrhoidal treatment are recurrence and significant perianal pain and the purpose of non-operative pro-

cedures is to try to minimize pain while maximizing outcomes. The most common and effective procedure is rubber-band ligation. The procedure is performed by placing rubber bands around the hemorrhoid pedicle, cutting off the blood supply causing the hemorrhoid to slough resulting fibrosis that helps to prevent future hemorrhoidal prolapses. Bands should be placed well above the dentate line to avoid pain from the sensory-rich anoderm. Studies have shown it to have outcomes at least equivocal to surgical hemorrhoidectomy, with slightly higher rates of post-procedure bleeding recurrences but less pain and similar overall satisfaction. There is also the very small chance of Fournier's gangrene with banding. Gangrene may be heralded by increasing pain, drainage, fevers, and an inability to void. Other techniques, including sclerotherapy, cryotherapy, and infrared coagulation, employ different modalities to achieve similar results. Sclerotherapy involves injections of sclerosing agents such as sodium tetradecyl, into the submucosa beneath the hemorrhoid. It is quick and inexpensive, but is associated with a higher rate of recurrent symptoms. Cryotherapy requires expensive equipment, has a high rate of recurrence, and can cause a foul-smelling discharge—it is therefore no longer used. Only infrared coagulation has shown results comparable to rubber band ligation, with reduced post-operative pain and only minimally inferior outcomes, and is a viable alternative. In general, it requires multiple applications and is not used as commonly any more. New techniques using lasers and radiofrequency ablation offer evolving technologies and more treatment options. Overall, non-operative techniques are associated with reduced morbidity and are all preferable to surgery choices.

F. Operative management options for grades I, II, and III hemorrhoids consist of three main procedures: excisional hemorrhoidectomy, stapled hemorrhoidopexy, and hemorrhoid artery ligation. Surgery can be indicated for grade III or IV hemorrhoids, relapse or continuation of symptoms following a non-operative procedure, or acute strangulation. Excisional hemorrhoidectomy can be performed with a variety of techniques and tools that remove the hemorrhoid. It is associated with greater morbidity than non-operative procedures like banding but is superior at controlling hemorrhoidal symptoms. Stapled hemorrhoidopexy uses a circular stapler to remove and staple a section of rectal mucosa approximately 4 cm above the dentate line. This maneuver elevates and fixes the hemorrhoid, preventing prolapse. Stapled hemorrhoidopexy has been to shown to offer comparable control of hemorrhoid symptoms, although these results are somewhat controversial. Studies have shown it to have decreased post-operative pain and recovery time but more severe, though not more frequent, complications. Long-term outcomes are similar between these two techniques, though recurrence is higher with the stapled procedure. Hemorrhoid artery ligation can be performed with or without Doppler guidance to ligate the hemorrhoidal arteries and cut off the blood supply to the hemorrhoid. Results have been found to be comparable to rubber-band ligation and stapled hemorrhoidopexy. Patients undergoing any of these procedures benefit from post-operative pain control with traditional NSAIDs or opiates, although opiates may cause worsening symptoms by decreasing bowel motility. Small trials have evaluated new drugs that may be of benefit, including diltiazem and liposome bupivacaine, but there is not substantial evidence supporting their use. Overall, operative management of internal hemorrhoids should focus on improving symptoms while minimizing complications.

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Anal Conditions: External Hemorrhoids

18

Michael Sigman and Dana Hayden

Introduction

Hemorrhoids are a commonly encountered, but often poorly understood clinical entity, both by patients and physicians. They have been reported to affect around 10 million Americans per year with a prevalence of 4.4%, making them one of the most common conditions treated by healthcare providers. External hemorrhoids are a venous plexus that encircles the anal verge and drain via the inferior rectal veins into the pudendal vessels. They are covered by anoderm and contain pain fibers. Communication exists between the internal and external hemorrhoid plexuses and enlargement of internal hemorrhoids will predispose to external hemorrhoidal engorgement.

Refer to Algorithm in Fig. 18.1

A/C. External hemorrhoids are most commonly encountered incidentally or when evaluating internal hemorrhoids, but they can be independently symptomatic. They may cause dull pain when they engorge or severe pain if acutely thrombosed. Large external skin tags or external hemorrhoids can affect hygiene or cause feelings of rectal pressure and discomfort with sitting or with sexual intercourse. Pruritus ani and perianal irritation from aggressive wiping may also be symptoms associated with external hemorrhoids. Patients are often bothered just by their presence and aesthetic appearance. Finally skin tags without any hemorrhoidal component may form from resolved engorged or thrombosed external hemorrhoids or after exacerbation of external hemorrhoids following vaginal delivery which can also cause the above symptoms.

B. Acute thrombosis of external hemorrhoids is typically self-limited. Thrombosed external hemorrhoids present with acute edema, ecchymosis, and significant pain. They may be precipitated by diarrhea or constipation or significant straining that causes trauma to the anal canal and/or venous stasis. A patient may report a mass or “marble” palpated externally with wiping or in the shower that is extremely tender to touch. The usual time course follows a sudden swelling after straining followed by severe pain over the first 3 days. Bleeding can occur if the overlying anoderm ulcerates. If left alone, the pain from

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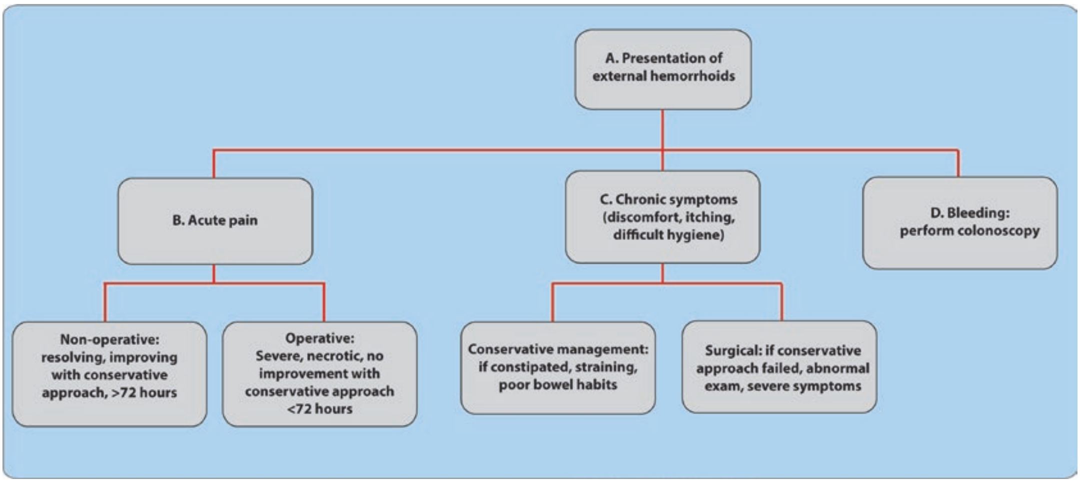

Fig. 18.1 Algorithm for presentation of external hemorrhoids

most acutely thrombosed external hemorrhoids will completely resolve over the course of 5–7 days from onset. Others may resolve with conservative management; only a minority of patients will require surgical intervention.

D. If bleeding is one of the symptoms, timing and type of bleeding is important to discern. If the patient reports clots or dark blood spontaneously, not just with defecation, this could be due to thrombosed external hemorrhoids. If bright red bleeding occurring with defecation is reported, this is more likely related to internal hemorrhoids or another anorectal disorder. If there is no acute pain, anoscopy and then colonoscopy likely should be performed.

Refer to Algorithm in Fig. 18.2

A. The history and physical examination are the two most important elements in the clinical decision-making involved in the treatment of external hemorrhoids. Internal hemorrhoidal bleeding typically occurs after bowel movements and is painless, where as that of external hemorrhoids can be independent of bowel habits and associated with the pain of thrombosis or ulceration. The physician should ask about bowel habits, straining with defecation, heavy lifting related to activity or occupation, recent childbirth, changes in medications, diet, or lifestyle, past treatment of hemorrhoids and the history or personal or family history of colorectal cancer or Crohn's disease. It is key to define how their symptoms impact the patient's quality of life (QoL). External hemorrhoids may affect activities like exercise, sexual intercourse, even sitting at work. Body image is also commonly affected by external hemorrhoids or skin tags.

B. When undertaking a physical examination, inspection of the perianal skin is critical. Examination may reveal external skin tags only, external hemorrhoids or internal prolapsing hemorrhoids. It is critical to evaluate for other conditions including anal cancer, condylomata, perianal excoriations or fissures. Acute thrombosis reveals an edematous lump at the anal verge caused by the clot. Often the blue-purple discoloration will confirm the diagnosis (Fig. 18.3). The mass may feel like a marble and be tender. If tolerable, digital examination of the anal canal and distal rectum should be performed.

C/D. Anoscopy is a useful adjunct and is performed unless acute thrombosis or anal pain is present. Assessing the internal hemorrhoids as well as identifying any other

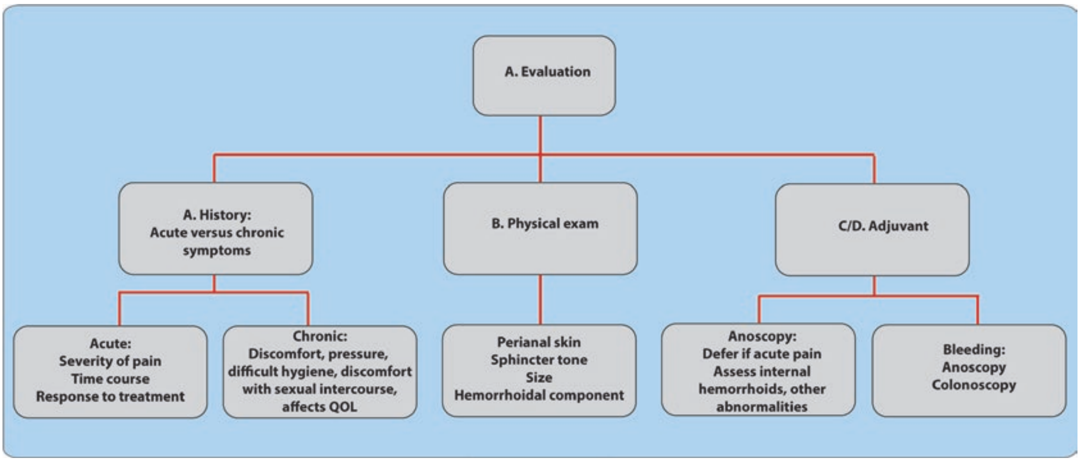

Fig. 18.2 Algorithm for evaluation of external hemorrhoids

Fig. 18.3 Acute thrombosis reveals an edematous lump at the anal verge caused by the clot. Often the blue-purple discoloration will confirm the diagnosis

anorectal abnormalities is important for treatment decisions. If the patient reports rectal bleeding, during defecation or spontaneously, colonoscopy should likely be performed following resolution of the acute symptoms. Thrombosed external hemorrhoids may become ulcerated or necrotic resulting in bleeding. Most external hemorrhoids do not bleed and other etiologies for the bleeding should be assessed with colonoscopy.

Refer to Algorithm in Fig. 18.4

A. Treatment of acutely thrombosed hemorrhoids largely depends of symptoms, exam and time course. The pain and edema of acute thrombosis have been shown to peak at 48 h and subside after 4–7 days. If the patient presents within 72 hours, we still try a course of conservative management with hydrocortisone, analgesia, warm baths and stool softeners/laxatives. If the patient cannot tolerate this approach or examination reveals extremely enlarged, necrotic hemorrhoids, surgical intervention should be pursued. Early excision of thrombosed external hemorrhoids was found to be associated with significant reduction in time to pain relief and recurrence compared with conservative management. Excision is generally well tolerated with the use of local anesthesia only. We perform this using lidocaine with epinephrine delivered via a small needle. We prefer to make an elliptical incision over the thrombosed hemorrhoid with removal of the thrombus. Bleeding is generally not a concern because the hemorrhoidal vessel is occluded with thrombus. If the thrombosis is extensive, intervention should be performed in the operating room. Excisional hemorrhoidectomy can be performed, with care not to excise too much

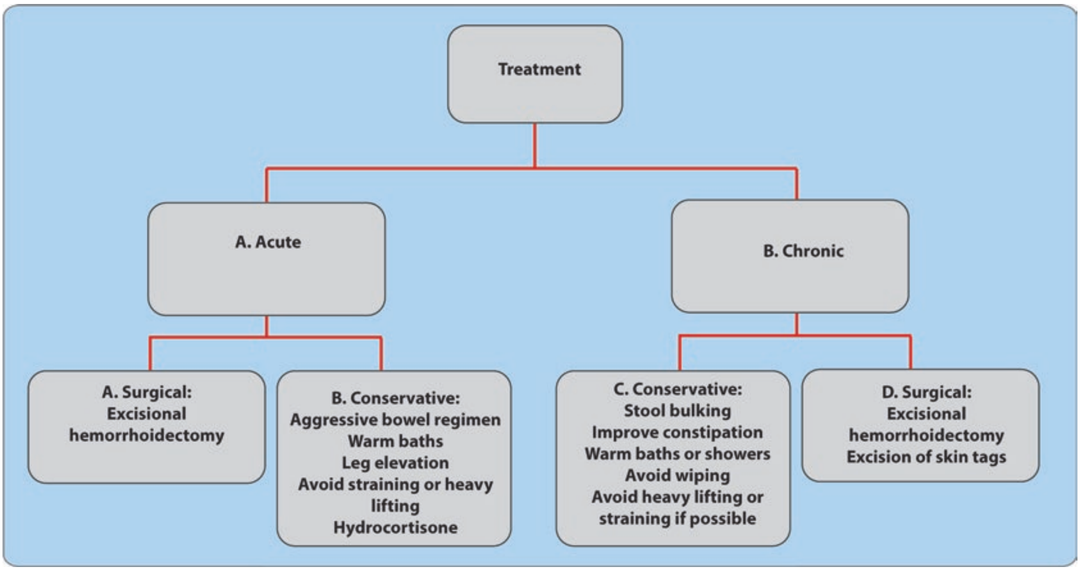

Fig. 18.4 Algorithm of treatment for external hemorrhoids

anoderm. Excision of the thrombosis is less invasive however is associated with higher recurrence. Excisional hemorrhoidectomy is more difficult in the acute setting due to the edema and excessive clots affecting the planes of the excision, but recurrence rate is very low. In our experience, excision of thrombosed external hemorrhoid is preferable to simple incision and extrusion of the thrombus in order to avoid recurrence. A minimum of 1 cm of normal anoderm should be left between columns to ensure the risk of anal stenosis is minimized, as well as avoidance of aggressive perianal skin resection in the acute edematous phase. The incision may be closed or left open to heal by secondary intention. Sitz baths, analgesics, and fiber supplements are prescribed in the initial post-procedure period.

In a patient who presents with acute thrombosis without necrosis, improving pain and symptom duration >72 h, conservative therapy should be utilized. This consists of warm baths, leg elevation and decreased activity, stool softeners or laxatives, avoidance of straining and heavy lifting and analgesics. The majority of patients will improve with this approach even in the setting of extensive thrombosis.

B/C. If the patient has chronic external hemorrhoids or external skin tags without acute symptoms, conservative management is the mainstay of treatment. This approach involves improved bowel regimen in order to reduce straining, stool bulking to help improve completion of bowel movements since residual stool can significantly contribute to difficult hygiene and anal itch. A "hands-off" approach is also important in order to avoid over-wiping, use of toilet paper or wet wipes that can cause perianal irritation. If the patient has large hemorrhoidal components to the external skin tags, then a short course of hydrocortisone cream while improving bowel habits may be helpful. Stopping overuse of steroid creams, suppositories and topicals may also improve symptoms.

D. If the patient reports significant impact on QoL due to the external hemorrhoids, other etiologies of their symptoms have been excluded and conservative measures have not improved symptoms, then surgical excision can be considered. There is no role

for office-based procedures such as banding for external hemorrhoids. Excisional hemorrhoidectomy or excision of anal skin tags should be performed in the operating room. An honest conversation regarding the postoperative pain and potential complications including damage to sphincter muscles or anal stricture or recurrent skin tags is necessary before the patient should agree to surgery. Also, if the patient's symptoms do not correlate with your exam findings, be wary about improving their symptoms with surgery and look for other causes. Excisional hemorrhoidectomy can be performed under general anesthesia or with a spinal block. This procedure should be performed in prone position. Sharp dissection, cautery, or advanced energy devices can be utilized for excision and these wounds can be closed or left open to heal by secondary intention. Postoperative pain control is improved with the use of long-acting local anesthetic and vigilant bowel regimen.

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Anal Conditions: Pilonidal Disease/Complex and Recurrent Pilonidal Disease

19

Richard S. Hoehn and Ian M. Paquette

Refer to Algorithm in Fig. 19.1

A. History and Presentation

Pilonidal disease affects 0.7% of the population, usually between the ages of 15 and 30, and is twice as common in men than women. Risk factors include having thick or hairy skin, increased sweating, a deep gluteal cleft, poor hygiene, obesity, and prolonged periods of sitting. It is generally accepted that this disease originates from traumatization of hair follicles in the natal cleft which leads to inflammation and a granulomatous foreign body-type reaction, which is exacerbated by the warm, moist, high-friction environment of this region. These conditions can lead to formation of an abscess or fistulous tracts. Clinical presentation is quite varied and can range from the presence of asymptomatic midline pits noted on physical examination to a complex network of draining sinus tracts, which can result in a debilitating decrease in quality of life. The most common initial presentation is pain and intermittent discharge, occasionally with bleeding, from one, or many sinus tracts in the gluteal cleft.

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B. Physical Examination

Diagnosis of pilonidal disease is straightforward and requires no imaging or testing. Physical examination will reveal one or several pits in the midline gluteal cleft. Patients may present with an acute abscess or a chronically draining sinus (Fig. 19.2). When present, abscesses in this region tend to present lateral to the midline (Fig. 19.3). The pilonidal cyst or sinus is usually found near midline at the top of the gluteal cleft, approximately 4–10 cm from the anus. The infected sinus is usually accompanied by other pits that communicate with the deeper cavity by an epithelized tract. It is important to differentiate pilonidal disease from other diagnoses such as hidradenitis suppurativa, Crohn's disease, perianal fistula, and other infectious processes. One major difficulty is assessing the degree of active disease below the skin. A common situation encountered is that the degree of extension under the skin can be much more extensive than it may appear based upon examination in the office. The surgeon must be aware of this possibility if operative intervention is to be offered.

Patients may also present with chronic pilonidal disease with a range of severity. Some patients have minimally symptomatic sinus tracts that may be treated with hair removal and potentially phenol

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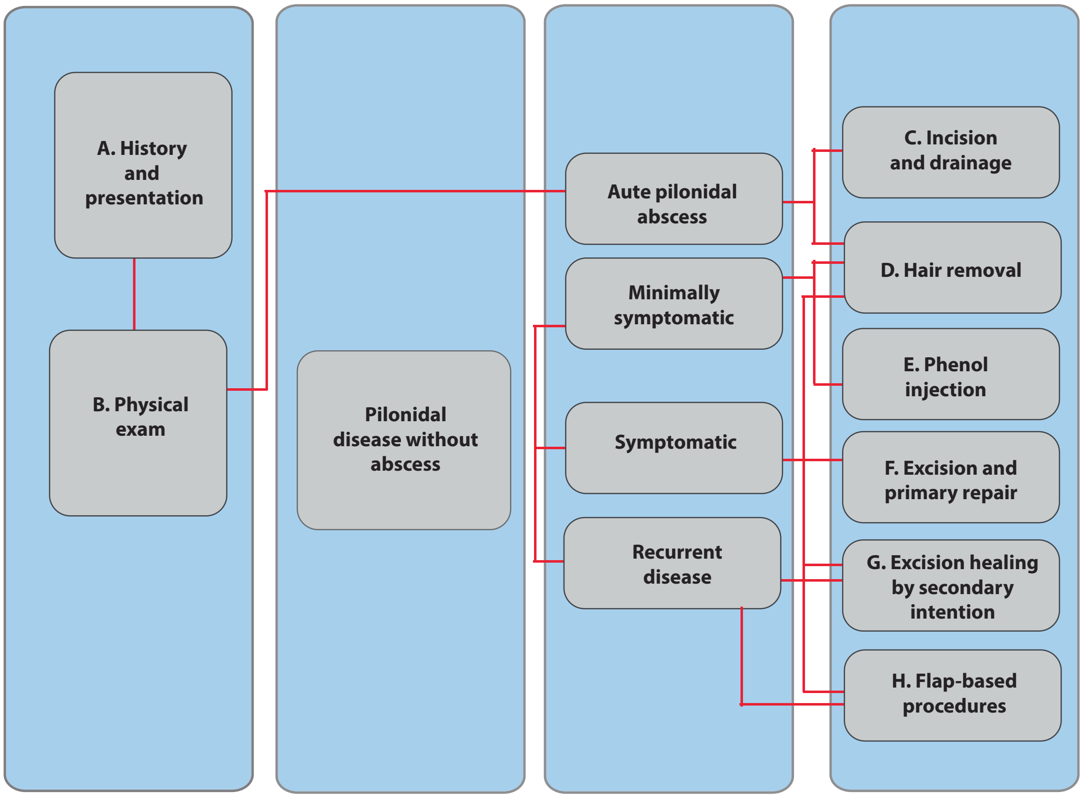

Fig. 19.1 Algorithm for treatment of pilonidal disease

injection. Some patients have chronic and symptomatic disease that requires excision with healing by primary intention, secondary intention, or a certain flap-based procedures if a deep cleft is found (cleft lift or Karydakis, below). These patients would benefit from hair removal as well (Fig. 19.3).

C. Incision and Drainage Only

For acute presentations with an abscess, whether primary or recurrent, incision and drainage is indicated. Using local anesthesia, a 1 cm cruciate incision is made close to midline and skin flaps are excised. Drainage is performed lateral to the midline. Drains or packing are not routinely indicated, and current literature does not support the use of antibiotics. Incision and drainage alone has a recurrence rate of >40%. Based upon the relatively high recurrence rate, patients are offered options including expectant follow-up, hair removal, or elective excision. Shaving of the area along with careful attention to hygiene may be beneficial in preventing recurrences.

D. Hair Removal

As pilonidal disease likely develops from hair follicle ingrowth, hair removal techniques have been shown to reduce the need for surgical intervention as well as disease recurrence when used either as an adjunct to surgical management. Therefore, hair removal can be considered for all patients presenting with current or past symptomatic pilonidal disease. Shaving has been the preferred treatment modality, and while laser hair removal has garnered much interest, data supporting this technique are insufficient to support routine use. This should be performed in conjunction with meticulous hygiene.

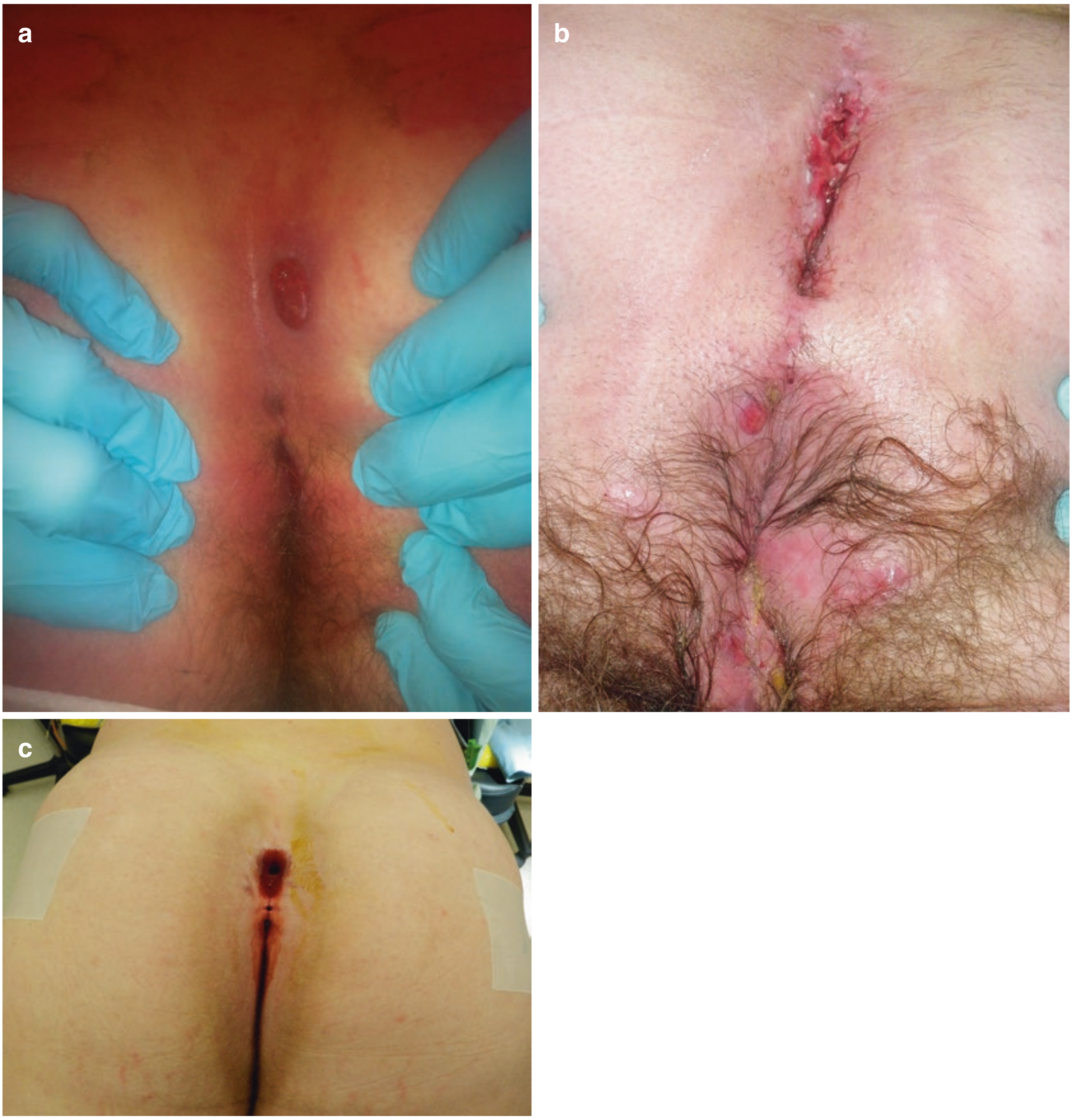

Fig. 19.2 Patient presenting with chronic pilonidal sinus in the gluteal cleft (With permission from Johnson EK. Pilonidal Disease and Hidradenitis Suppurativa. In: Steele SR, Hull TL, Read TE, Saclarides TJ, Senagore AJ, Whitlow CB, editors. The ASCRS Textbook of Colon and Rectal Surgery, 3rd ed. Springer, New York; 2016:pp: 289–307 © Springer)

E. Phenol Injection

Phenol injection is a potential non-operative adjunct to treatment that is less commonly used. To whatever extent possible, tracts should be debrided free of any excess hair or debris and curetted to remove excessive granulation tissue. Under a local anesthetic block, the injection of 1–2 mL of 80% phenol solution causes epithelial destruction and intense inflammation that has a 60–95% success rate at closing pilonidal tracts. This therapy induces significant discomfort and may require inpatient admission for pain control. This treatment is best reserved for patients with limited sinus tracts and mild to moderate symptoms from their pilonidal disease.

Fig. 19.3 Pilonidal abscess presenting to the left of the midline (With permission from Johnson EK. Pilonidal Disease and Hidradenitis Suppurativa. In: Steele SR, Hull TL, Read TE, Saclarides TJ, Senagore AJ, Whitlow CB, editors. The ASCRS Textbook of Colon and Rectal Surgery, 3rd ed. Springer, New York; 2016:pp: 289–307. © Springer)

F. Excision and Primary Repair

Patients with chronic, symptomatic pilonidal disease may benefit from excision of the diseased tissue. Excision of the pilonidal abscess and tracts followed by primary surgical repair has led to faster healing rates than healing by secondary intention in multiple prospective, randomized trials. However, primary closure may be associated with increased rates of recurrent disease. When primarily closing wounds in this area it is important to leave the surgical wound off the midline. Additionally, it is important to excise only the tissue involved with the sinus tracts rather than excising down to the fascia, encompassing large amounts of normal tissue. This unnecessary step creates a large deadspace and leads to complications in healing. Midline surgical wounds, and large volume excisions, have been independently associated with delayed wound healing following primary closure. A meta-analysis found that off-midline closures had a lower failure rate (3–5% versus 9%) and recurrence rate (1–3% versus 9.5%) compared to midline closure. Drain placement in this setting has demonstrated improved healing with no effect on disease recurrence, though it is only like necessary in the setting of a larger volume excision leaving significant deadspace. In scenarios with smaller volume excisions, a layered primary closure will suffice.

G. Excision and Healing by Secondary Intention

For patients with a substantial excision, or those who have failed primary closure, excision and healing with secondary intention is a potential next step. For acute or recurrent disease, curettage of the abscess cavity may improve healing and lower recurrence rates. It is important to adhere to sound principles when performing this procedure. The goals are to eradicate the subcutaneous sinus tracts and remove any excessive granulation tissue and debris. Opening the tracts over a fistula probe and injection of small quantities of methylene blue into the tracts can be helpful adjuncts to achieving these goals. If these principles are adhered to, the disease can often be excised without creating excessively large soft tissue defects. Marsupialization of the wound edges may reduce the wound to a more manageable size and precipitate quicker healing. In the event of a larger excision, negative pressure wound therapy has shown promise as an adjunctive treatment for complex, recurrent pilonidal disease, but current literature has yet to define a clear role for this therapy. If this type of procedure is planned, the patient must be counseled on the expected prolonged period of time to achieve complete healing.

H. Flap-Based Procedures

For patients with complex pilonidal disease or recurrent disease following basic excision and closure, flap-based closure should be considered. There are multiple flap procedures, each with a recurrence rate of <10%.

Fig. 19.4 The Bascom or cleft-lift technique starts with marking a "safe zone" prior to surgery (With permission from Johnson EK. Pilonidal Disease and Hidradenitis Suppurativa. In: Steele SR, Hull TL, Read TE, Saclarides TJ, Senagore AJ, Whitlow CB, editors. The ASCRS Textbook of Colon and Rectal Surgery, 3rd ed. Springer, New York; 2016:pp: 289–307. © Springer)

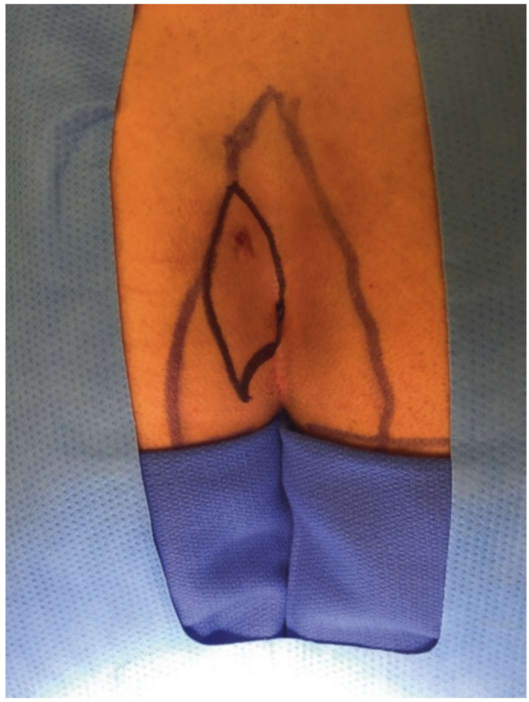

Fig. 19.5 To help rotate the distal portion of the wound to a lateral position, a scimitar shape is used on the distal incision (With permission from Johnson EK. Pilonidal Disease and Hidradenitis Suppurativa. In: Steele SR, Hull TL, Read TE, Saclarides TJ, Senagore AJ, Whitlow CB, editors. The ASCRS Textbook of Colon and Rectal Surgery, 3rd ed. Springer, New York; 2016:pp: 289–307. © Springer)

Cleft elevating procedures such as the Karydakis and Bascom procedures, can be considered as first-line surgical treatment for individuals with a very deep gluteal cleft, or in cases of recurrent pilonidal disease. The technical challenge lies in elevating the distal most aspect of the gluteal cleft, and the incision is often curved in the inferior location to account for this. Groups have published very low complication and recurrence rates with each technique, and practitioners should choose a technique based on experience and comfort with the procedure.

The Karydakis flap involves a midline excision of the pilonidal tracts and diseased tissue with creation of an elliptical defect. The excision favors the more diseased side, with preservation of normal tissue on the contralateral side to use as a flap. Next, a beveled flap is created from the more medial tissue and is sutured laterally to the sacrococcygeal fascia to avoid midline tension, followed by an off-midline skin closure. This technique has a wound complication rate of 8% and recurrence rate of 2%. Advantages include a tension-free closure that is off-midline as well as flattening of the natal cleft. It is also one of the easier flap procedures to perform.

The Bascom or cleft-lift technique is a simple but intricate procedure that is designed to lift the natal cleft and provide an off-midline closure. Prior to surgery, a "safe zone" is marked on the skin to indicate the limits of dissection (Fig. 19.4). The buttocks are taped apart and a triangular incision is made with the apex above and lateral to the cleft. The distal portion of the incision is scimitar shaped in order to facilitate closure near the anus (Fig. 19.5). The flap is

Fig. 19.6 The Limberg or rhomboid flap involves excision of all diseased tissue in the midline in a diamond- or rhomboid-shaped block (With permission from Johnson EK. Pilonidal Disease and Hidradenitis Suppurativa. In: Steele SR, Hull TL, Read TE, Saclarides TJ, Senagore AJ, Whitlow CB, editors. The ASCRS Textbook of Colon and Rectal Surgery, 3rd ed. Springer, New York; 2016:pp: 289-307. © Springer)

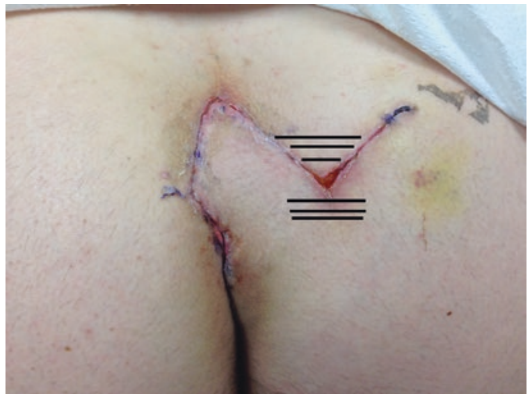

Fig. 19.7 Completed Limberg flap (With permission from Johnson EK. Pilonidal Disease and Hidradenitis Suppurativa. In: Steele SR, Hull TL, Read TE, Saclarides TJ, Senagore AJ, Whitlow CB, editors. The ASCRS Textbook of Colon and Rectal Surgery, 3rd ed. Springer, New York; 2016:pp: 289–307. © Springer)

raised with care to leave the subcutaneous fat in place. The skin flap is excised, hair and granulation tissue debrided, and the flap is sutured over a drain. Recurrence rates are around 4%. This procedure is not ideal for patients with complex recurrent disease, large wounds, and disease close to the anus.

Rotational flaps are more involved procedures and generally second-line therapy for patients with multiple-recurrent or very extensive disease.

The Limberg or rhomboid flap involves midline excision of the pilonidal disease, with a diamond- or rhomboid-shaped incision, (Fig. 19.6) down to the presacral fascia and rotational fasciocutaneous coverage. The flap must be of the same thickness as the excised tissue, and closure is with layered absorbable sutures and closed-suction drain (Fig. 19.7). Recurrence rates with this procedure are 0–6%, the same as the wound complication rates, which may include hematoma or seroma formation as well as areas of minor wound separation due to tension closure. This is a preferred procedure in the setting of complex recurrent disease. However, due to the complexity of the procedure, a surgeon must either have extensive experience with this technique, or collaborate with a plastic surgeon who is well versed in this technique. The V-Y advancement flap and the Z-plasty, both of which report >90% healing and low disease recurrence, are other closure options for wide excision of complex disease. However, the V-Y flap uses a midline closure, often over a drain, and both are considered inferior to the above techniques.

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20 Anal Conditions: Pruritus Ani

Brian L. Bello and Konstantin Umanskiy

Refer to Algorithm in Fig. 20.1

A. The urge to itch in pruritus ani is mediated by the extensive, unmyelinated C-fibers that are predominant in the anoderm and perianal skin. Stimulation of these fibers leads to scratching and frequent wiping in order to relieve the urge. This often contributes to excoriation and cutaneous injury, which causes additional stimulation of the C-fibers, inciting more itching and scratching. This may ultimately lead to a self-defeating vicious cycle (Fig. 20.2). Pruritus ani is reported to affect up to 5% of the population. The condition is more common in men than women with a 2:1 ratio. It is usually seen in older adults but can affect people of any age. Refractory cases have been described and can lead to severe physical and emotional distress.

B. A thorough history must be obtained as this often gives clues as to the likely cause of itching. Specific aspects of the history should include the following:

- Bowel habit: frequency, constipation, incomplete evacuation, diarrhea, seepage, stool consistency, change in stool caliber.
- Diet: coffee, chocolate, spicy foods, dairy, citrus, tomatoes; request food journal.
- Toileting behavior and hygiene: time on toilet, straining, types of wipes, method of wiping, cleansing agents.
- Local irritants: creams, wipes, undergarments tight-fitting or synthetic material undergarments, anal moisture.
- Systemic signs: abdominal pain, weight loss, fevers, fatigue.
- Past medical history: diabetes, dermatologic conditions, malignancy, sexual practices, gastrointestinal disorders, radiation, sexually transmitted diseases, previous anorectal surgery.

A careful external evaluation should be performed noting the severity and extent of any inflammation or skin changes. Masses, irregularity, and induration should be assessed by digital anorectal examination. Anoscopy may reveal abnormalities in the anal and distal rectal mucosa and help to identify or exclude anorectal causes of itching, including hemorrhoids, anal fissure, and fistula-in-ano. While there is no specific diagnostic laboratory test for pruritus ani, an HIV test can be beneficial and a CBC may suggest an infectious or malignant process.

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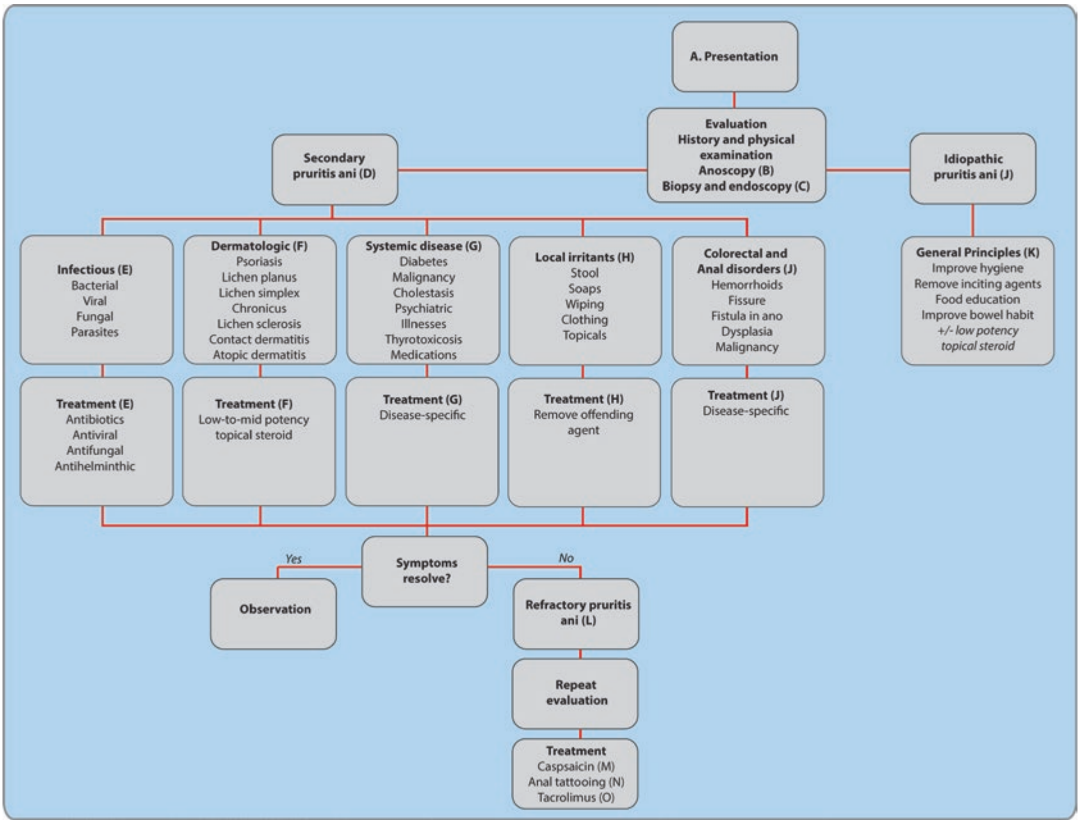

Fig. 20.1 Algorithm for diagnosis and treatment of pruritus ani

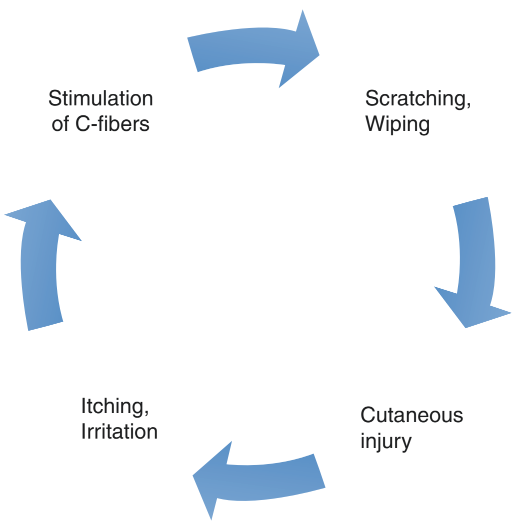

Fig. 20.2 Pruritus ani: a vicious cycle

C. Biopsy is an indispensable modality for evaluation of anal itching. Any abnormal appearing lesion or perianal skin changes should be biopsied. This can easily be done in the office setting with local anesthetic and a 15-blade scalpel or punch biopsy. Endoscopy is a useful adjunct to perianal biopsy and should be performed to rule out malignancy especially if the patient is older or has concerning symptoms such as abdominal pain, weight loss, change in bowel movements, or blood in the stool.

D. In up to 75% of cases of pruritus ani, an identifiable etiology can be found. While there are dozens of conditions associated with anal itching, most of them can be classified as infectious, dermatologic, systemic, local irritants, or colorectal- and anal-specific causes (Fig. 20.1). Here, we will review the most common causes.

E. *Infectious* causes of pruritus ani include bacterial, fungal, viral and parasitic infections.
   - Common *bacterial* causes of pruritus ani include erythrasma, gonorrhea, and syphilis.
     – *Corynebacterium minutissimum* causes erythrasma which affects the perianal area, axilla, thighs, and toe-web spaces. A classic, large pink-reddish patch is seen initially which eventually turns brown (Figure 20.3a). Under an ultraviolet lamp, the lesions appear with a coral to salmon fluorescence from the porphyrin production made from the bacteria. Treatment is erythromycin 250 mg four times a day for 10 days.
     – Patients who present with tenesmus, purulence, proctitis, in addition to pruritus,

Fig. 20.3 Bacterial infections. (**a**) Erythrasma. Courtesy of Lee Smith, MD; (**b**) Purulence seen with gonorrhea infection. Courtesy of Lee Smith, MD; (**c**) Primary chancre of syphilis. Courtesy of Lee Smith, MD

should be tested for gonococcal infection (Figure 20.3b). A swab should be done and placed on Thayer-Martin media. Anal gonorrhea is treated with ceftriaxone 250 mg IM plus azithromycin 1 g PO.
  - Syphilis often presents as a *painless* chancre, starting as a papule that eventually ulcerates (Figure 20.3c). In contrast to syphilis, *painful* ulcers in the perianal region are usually associated with herpes and chancroid. Syphilis is caused by the spiral-shaped bacterium *Treponema pallidum.* These spirochetes can be seen on dark-field microscopy from scrapings obtained at the base of the lesion. Alternatively, serologic screening can be done with a nontreponemal test. Treatment is a one-time dose of penicillin G 2.4 million units IM.
- Pruritus ani from a *fungal* infection presents with a markedly erythematous rash (Fig. 20.4). This condition is more common in patients with diabetes mellitus, obesity and immunocompromised states. Histopathology reveals hyphae of a fungus seen with a potassium hydroxide preparation. These patients often respond to topical nystatin 100,000 units/g two to three times a day.
- *Viral* etiologies of pruritus ani include herpes (HSV) and condyloma.
  - HSV infection often presents as painful, scattered lesions including ulcers and vesicles (Figure 20.5a). A viral culture taken from the base of the ulcer or from vesicular fluid is usually diagnostic. Treatment of an acute episode is acyclovir 800 mg three times a day for two days or valacyclovir 500 mg PO three times a day. For patients with frequent recurrences, acyclovir 400 mg twice daily or valacyclovir 500 mg daily has been advocated.
  - Large anal condylomata can cause pruritus and usually require excision and/or fulguration in the operating room (Figure 20.5b).
- Pinworm (*Enterobius vermicularis*) is a *parasitic* roundworm that can lead to pruritus ani. Gravid female pinworms migrate from the anus and eggs are left on the perianal folds causing irritation. This condition, more commonly affecting children, is notable for nocturnal itching. Scotch tape applied to the perianal region can reveal the eggs of the pinworm. Lactophenol can be used to enhance the slide (Fig. 20.6). Treatment is mebendazole 100 mg PO as a single dose.

Fig. 20.4 Severe fungal infection. (With permission from Smith L. Perianal Dermatologic Disease. In: Gordon PH and Nivatvong S, editors. Principles and Practices of Surgery for the Colon, Rectum, and Anus. third ed. 2007 © Informa Healthcare publishing)

F. The most common dermatologic conditions associated with pruritus ani are discussed below.
- *Psoriasis* presents with erythema and sharply defined boundaries with or without the typical scaling (Fig. 20.7). Patients with psoriasis will characteristically have lesions affecting the groin, genitalia, intergluteal cleft, axilla, and umbilicus. Treatment is usually a low to mid-potency topical steroid. Tacrolimus can also be used.

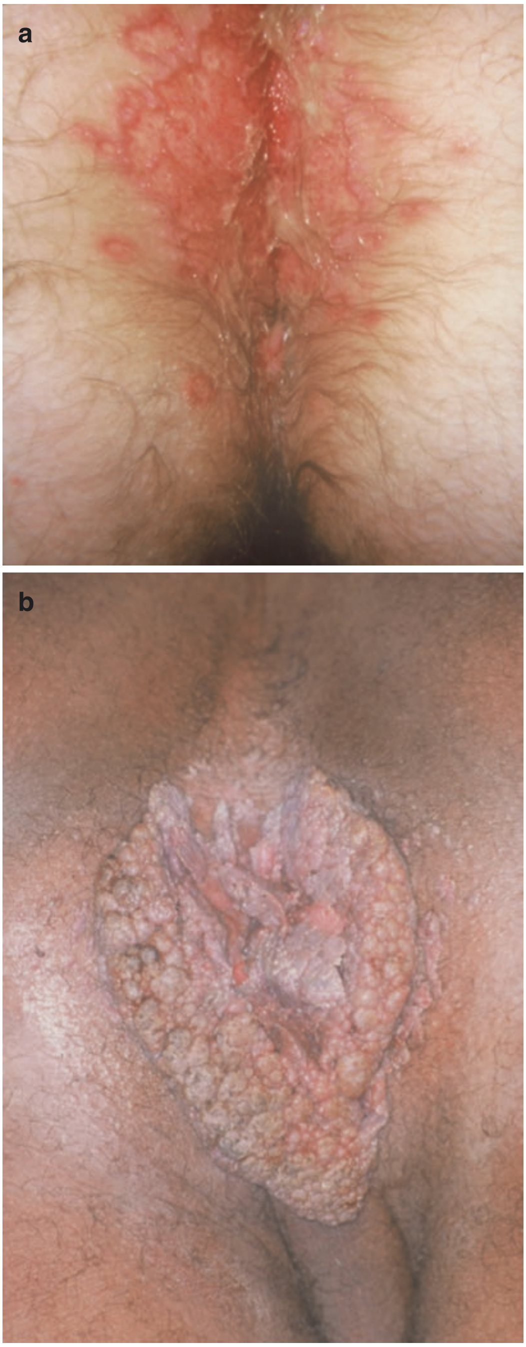

Fig. 20.5 Viral infections. (**a**) Herpes lesions Courtesy of Lee Smith, MD; (**b**) Anal condylomata. Courtesy of Lee Smith, MD

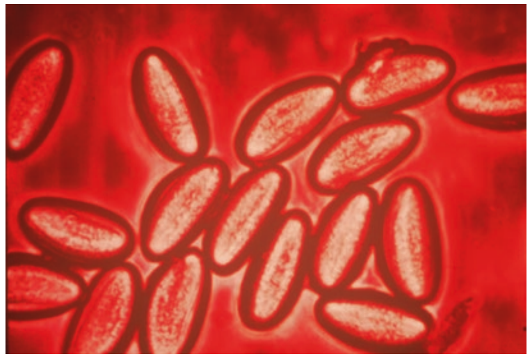

Fig. 20.6 Eggs of *Enterobius vermicularis*. (With permission from Smith L. Perianal Dermatologic Disease. In Gordon PH and Nivatvong S, editors. Principles and Practices of Surgery for the Colon, Rectum, and Anus. 3rd edn. 2007 © Informa Healthcare publishing)

- *Lichen simplex chronicus* is a condition that can result from chronic diarrhea. Inflammation in the perianal area results in thickened (lichenified) and cracked, excoriated skin (Fig. 20.8). Treatment is focused on controlling the frequency of bowel movements. Loperamide and silver sulfadiazine can be used with addition of low dose hydrocortisone for more severe cases.
- *Lichen sclerosis (formerly lichen et atrophicus)* presents mainly in women with a thinning and wrinkling of the perianal skin, also known as a "cigarette-paper" appearance (Fig. 20.9). This also classically affects the labial skin and perineum. Lichen sclerosis may be associated with squamous cell carcinoma. Thus, the affected area should be examined at least annually and a biopsy should be considered for any suspicious lesions. Treatment is a topical glucocorticoid like clobetasol propionate 0.05% for 6–8 weeks. Tacrolimus has also been used for this condition.
- *Contact dermatitis* is a result of a mechanical or chemical irritant that may act as an allergen. Some soaps, cleansers, alcohol and feces can cause macular erythema, hyperkeratosis, and fissuring (Fig. 20.10). Patch testing by an allergist or dermatologist can be useful to determine if there is an inciting allergen, especially in severe or refractory contact dermatitis. Treatment is Sitz baths with or without vinegar, low dose hydrocortisone, oral steroids, or antihistamines.
- Pruritus ani with thickened skin and leathery patches may suggest *atopic dermati-*

Fig. 20.7 Psoriasis around anus and intergluteal cleft. Courtesy of Lee Smith, MD

Fig. 20.8 Lichen simplex chronicus. (With permission from Finne CO, Fenyk JR. Dermatology and Pruritus Ani. In: Beck DE, Roberts PL, Saclarides TJ, et al., editors. The ASCRS Textbook of Colon and Rectal Surgery. 2nd edn. 2011 © Springer publishing)

Fig. 20.9 Lichen sclerosis. Courtesy of Lee Smith, MD

tis. This is often hereditary and presents at an earlier age than other causes of pruritus. In addition to the anus, this can be seen in the neck, antecubital, and popliteal fossas. Treatment is with a topical barrier like petroleum jelly, and anti-inflammatory drugs and antihistamines.

G. Systemic causes of pruritus ani include diabetes mellitus, leukemia and lymphoma, cholestasis, thyrotoxicosis, and psychiatric illnesses. Anxiety, stress, fatigue, and obsessive compulsive tendencies have been shown to play a role. Often a generalized pruritus is noted in these systemic conditions. Treatment should focus on disease-specific interventions. Systemic medications such as antibiotics (tetracycline and colchicine), quinidine, and peppermint oil have been implicated as well.

H. *Local irritants* are often the cause of anal itching. Several of these have been discussed above under contact dermatitis. Fecal seepage is the most common irritant responsible for pruritus. This is further exacerbated by excessive soaps and wiping in an effort to clean the perianal region. Anal seepage can be exacerbated by certain foods that can alter the pH of the stool or lower sphincter tone. In addition, ill-fitting, synthetic clothes and top-

Fig. 20.10 Contact dermatitis. (With permission from Smith L. Perianal Dermatologic Disease. In Gordon PH and Nivatvong S, editors. Principles and Practices of Surgery for the Colon, Rectum, and Anus. 3rd edn. 2007 © Informa Healthcare publishing)

ical creams can trap moisture around the anus. Treatment involves removing the offending agent, keeping the area dry (cotton ball or folded cotton gauze), and avoiding further trauma to the skin. In the case of fecal seepage, bulking agents are an effective first line treatment.

I. Colorectal and anal specific causes of pruritus ani include hemorrhoids, fissure, fistula-in-ano, dysplasia, and malignancy. 6–11% of patients with pruritus ani can have an underlying cancer. This underscores the importance of considering an endoscopy as part of the diagnostic workup. The mainstay of treatment is addressing the primary cause.

J. Despite extensive work up, no clear etiology of pruritus ani can be identified in up to 25% of patients. These cases are classified as *idiopathic*, or *primary*, *pruritus ani* and are considered as a diagnosis of exclusion.

K. The majority of patients with *either* secondary or primary pruritus ani will benefit from simple, *general principles* including improving anal hygiene, removing any potential inciting agents, food education, and improving bowel habit. These interventions can be effective in up to 90% idiopathic cases.
  - *Inciting agents:* Any inciting factors, mechanical or chemical irritants, trauma, and scratching should be avoided.
  - *Hygiene:* Sitz baths without additives after defecation often helps keep the perianal clean. Bidets are becoming more popular as an alternative. Patients should be counseled to avoid soaps, scrubbing, and aggressive wiping. Excessive moisture can cause hygiene problems. Blotting with damp toilet paper should be used instead of a moist wipe. Using a hair dryer on the lowest setting or dabbing with a towel is also beneficial. Light cotton as undergarments should be used instead of tight fitting, synthetic underwear. A dry cotton ball or gauze placed at the anus can be used to limit moisture in the area. As a general rule, topical creams should be avoided initially as they may trap moisture.
  - *Food education:* Patients may benefit from avoiding coffee, cola, beer, tomatoes, chocolate, tea, citrus, and lactose containing foods.
  - *Bowel habit:* High fiber diet and bulking agents are helpful to in absorbing water from stool, in turn decreasing fecal seepage. Antidiarrheals such as loperamide or atropine/diphenoxylate are recommended if needed.

  If following these simple, general principles is not successful after four to six weeks, a short-course trial of a low-potency topical steroid (1% hydrocortisone) can be tried twice a day for two weeks. This should be tapered off using a barrier cream containing zinc oxide to prevent skin atrophy.

L. Clinicians should be prepared to manage *refractory pruritus ani* if there is no resolu-

tion of symptoms despite previous treatment. Repeating a thorough history may identify an inciting event that may have not been identified initially. Journals with foods and/or timing of symptoms can demonstrate a temporal relation to onset of symptoms. A biopsy and endoscopy should be performed if they were not done at the initial evaluation. Similar to initial evaluation, the focus should be on finding an underlying cause. These patients will need to be counseled that refractory pruritus ani may be a chronic condition requiring a long-term treatment plan and their expectations need to be set that treatments are aimed at improving symptoms rather than complete resolution. Capsaicin, anal tattooing, and tacrolimus are effective in the management of refractory pruritus ani.

M. *Capsaicin* is chili pepper extract and works by depleting substance P and damaging C-fiber terminals, the fibers that mediate itch signaling (Fig. 20.2). A temporary burning sensation replaces the overwhelming urge to scratch. Lysy et al. (2003) performed a randomized, control trial on capsaicin versus menthol as placebo in patients with idiopathic refractory pruritus ani. Patients kept a 28 day symptom diary and scored their symptoms on a 1 to 5 point scale. Capsaicin 0.006% for four weeks was shown to improve these itching and burning sensation scores in 75% of patients when compared to placebo.

N. *Anal tattooing* involves the intradermal injection of methylene blue which destroys dermal nerve endings. The solution has been modified to avoid skin necrosis which was reported in up to 25% patients. The perianal area is injected with 10 ml of 1% methylene blue plus 5 ml normal saline plus 7.5 ml 0.25% bupivacaine with epinephrine plus 7.5 ml of 0.5% lidocaine. The tattoo disappears in about three to four weeks. Patients can sometimes have prolonged numbness around the area or see bluish urine initially. Transient fecal incontinence has also been described. In several retrospective studies, approximately 80–100% of patients had some improvement, while 20–80% patients had complete resolution of pruritus ani on long-term follow up (Table 20.1). A second injection may sometimes be helpful.

Table 20.1 Summary of Studies on Anal Tattooing

Author and Year	Number of patients	Key findings
Eusebio et al. 1990	21	100% had improvement in symptoms
Farouk and Lee 1997	6	83% had improvement in symptoms; 50% needed a second injection
Mentes et al. 2004	30	93% had improvement in symptoms (5 pts required an additional treatment); 76% had complete resolution at 12 months
Sutherland et al. 2009	49	96% had improvement in symptoms (4 pts required an additional treatment); 57% had complete resolution at 8 weeks
Samalavicius et al. 2012	10	100% had improvement in symptoms at 4 weeks; 20% had complete resolution at 5 years

Table 20.2 Summary of Studies on Tacrolimus

Author and Year	Number of patients	Key findings
Suys 2012	21	68% had improvement in symptoms at 2 weeks
Ucak et al. 2013	32	80% had improvement in symptoms at 4 weeks; 18.75% had complete resolution at 18 weeks

O. *Tacrolimus* 0.03–0.1% is a non-corticosteroid, macrolide anti-inflammatory and has recently been studied in small series. This agent may be a good alternative to topical steroids or as a replacement when tapering off steroids to help avoid skin atrophy. Two studies have shown an improvement in itch intensity, itch frequency, and Dermatology Life Quality Index (DLQI), a quality-of-life questionnaire (Table 20.2).

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21 Anal Conditions: Hidradenitis Suppurativa

H. Hande Aydinli and Emre Gorgun

Refer to Algorithm in Fig. 21.1

A. Hidradenitis suppurativa (HS) is a chronic, progressive inflammatory disease of the apocrine gland-bearing skin that most commonly effects axillary (Fig. 21.2b) and perianal areas (Fig. 21.2d). Overall, ~30% to 50% of patients with HS have perianal lesions although the inguinal (Fig. 21.2c) and inframammary (Fig. 21.2a) regions can be involved as well. Perianal HS commonly appears as a single lesion or combined with bilateral axillary lesions. Early signs include open comedones (clogged hair follicle) and tender subcutaneous papules (Fig. 21.2a). Additional inflammatory nodules can subsequently form and progress to painful draining abscesses, sinus tracts (Fig. 21.2d) and scarring. The skin lesions can interfere with activities of daily living and be difficult to heal. Patients with severe disease commonly suffer from poor quality of life and sexual dysfunction.

The worldwide prevalence is 0.1 to 4% and females are more likely to be affected. The mean age of onset is 20 to 24 years, and advanced age is correlated with disease severity. Cigarette smoking and obesity are known risk factors. Dietary triggers include dairy products and highly refined simple carbohydrates. The pathophysiology of the disease still remains controversial. The most accepted theory is that follicular epithelial hyperplasia and infundibular hyperkeratosis lead to follicular occlusion, which subsequently causes secondary inflammation of the apocrine glands. Endocrine and genetic factors have been proposed as well.

B. Diagnosing the disease can be challenging due to the absence of a pathognomonic test. The reported median delay between the appearance of initial symptoms and diagnosis changes from 2.3 ± 5 years (mean ± SD) to 12 years. In some cases, non-specific lesions can be confused for other skin conditions such as simple infections or anogenital Crohn's disease, especially if patients seek care from a number of providers and care points, including general care practitioners and emergency rooms. Also, not all patients present for care, initially. Diagnosis is made clinically based on the presence of typical lesions, the distribution patterns of these lesions and a history of recurrent disease. Physical examination is the most important part of the evaluation. Findings generally include skin thickening, induration, abscess formation, draining sinuses and contractures. There are no diagnostic imaging or laboratory studies specific for HS. Ultrasonography can

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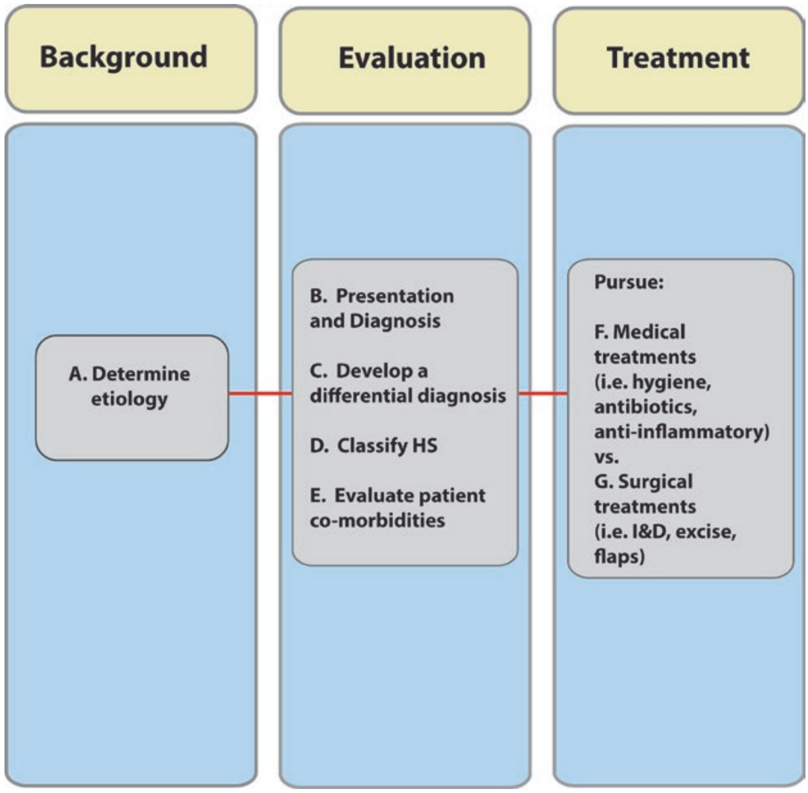

Fig. 21.1 Algorithm for the evaluation and management of Hidradenitis Suppurativa (HS)

be used to evaluate skin lesions typically fistulous tracts and fibrotic scarring in lesions, which might be worse prognostic factors in terms of response to the medical treatment. With perianal lesions, the extent of the disease might not always appreciated with physical examination; magnetic resonance imaging (MRI) may therefore be necessary. Pelvic MRI may show the extent of the perianal disease and helps exclude Crohn's disease by revealing anorectal fistulizing disease. In patients with perianal HS, MRI typically shows subcutaneous edema with possible superficial sinus tracts; the anal sphincter and levator plate are usually not involved. Patients with severe disease should be evaluated for sepsis with basic laboratory assessment including a complete blood cell count with differential, and basic metabolic profile with C-reactive protein. Biopsy and culture may be beneficial in certain instances of refractory or atypical disease. According to the stage of the disease process, typical pathology shows hyperkeratosis and occlusion of hair follicles, peri-folliculitis, and invasion of the dermis by inflammatory cells, granulation tissue and giant cells. It is important to use biopsies exclude SCC in chronic cases.

C. A number of diseases should be considered in the differential diagnosis including; acne, actinomycosis, anal fistula, carbuncles, cat scratch disease, cellulitis, Crohn's disease, dermoid cyst, granuloma inguinale, erysipelas, furuncles, inflamed epidermoid cyst, lymphadenopathy, lymphogranuloma venereum, perirectal abscess, pilonidal disease, and tuberculosis abscess.
D. Different classification/scoring systems have been created to assess disease severity. The Hurley classification system is the most commonly used due to its simplicity (Table 21.1). For a more detailed categorization and/or research purposes, the Sartorius system and latent classification systems were established over time (Tables 21.2 and 21.3). The Hidradenitis Suppurativa Clinical Response

Fig. 21.2 (**a**) HS inframammary region comedones and inflammation, (**b**) Left axillary region abscesses, sinus tracts and scarring, (**c**) inguinal and suprapubic region lesions with extensive inflammation, (**d**) perianal region with abscesses and sinus tracts with seton placement

(HiSCR) is a newer and well-accepted method of assessing the clinical response to medical treatment in patients with HS. The HiSCR typically assesses three lesions including abscesses (fluctuant, with or without drainage, tender or painful), inflammatory nodules (tender, erythematous, pyogenic granuloma lesion) and draining fistulas (sinus tracts, with communications to skin surface, draining purulent fluid). A clinically meaningful response is defined as a 50% reduction in inflammatory lesion count (abscesses and inflammatory nodules) and no increase in the number of abscesses and draining fistulas when compared from baseline.

E. Several comorbid disorders are correlated with HS including inflammatory bowel diseases (IBD)—mainly Crohn's disease—

Table 21.1 Hurley clinical staging system for Hidradenitis Suppurativa

Stage I-mild disease	Single/multiple abscess formation without sinus tracts or scarring
Stage II-moderate disease	Recurrent abscesses with sinus tracts and scarring, single or multiple widely separated lesions
Stage III-severe disease	Diffuse or almost diffuse involvement, or multiple interconnected sinus tracts and abscesses across the entire area

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Table 21.2 Modified Sartorius staging system for Hidradenitis Suppurativa

Anatomical regions involved: axilla, groin, gluteal (anal) or other region	– 3 points for each region
Numbers and scores of lesions for each region	– nodule 1 point – fistula (sinus tracts) 6 points – scars 1 points
The longest distance between two relevant lesions (or size of lesion if single) for each region	< 5 cm, 1 point 5–10 cm, 3 points > 10 cm, 9 points
Whether all lesions are separated by normal skin?	– yes, 0 – no (= Hurley III), 9 points

Table 21.3 Latent or phenotypic classification proposed by Canoui-Poitrine et al.

Latent classification	Phenotype	Affected region
LC1	Axillary-mammary	Axilla, breast, perineum, inguinal
LC2	Follicular	Ears, chest, backs, legs, axillary, breast
LC3	Gluteal	Gluteal folds (anal)

Latent or phenotypic classification created sub groups of HS based on clinicopathological features to help the clinician identify the disease nature more properly
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spondyloarthropathy, genetic keratin disorders and acne. HS prevalence in patients diagnosed with IBD ranges from 1.8% to 12.8%. In a review of 61 patients diagnosed with anal HS, 24 patients (39%) had a concurrent diagnosis of Crohn's disease. Diagnosis of HS in the presence of anal fistulas can be challenging, but usually these fistulas are limited to the distal two thirds of the anal canal when secondary to HS.

Squamous cell carcinoma (SCC) arising in the setting of HS is fairly uncommon but has been reported in the literature and is associated with a worse prognosis and eventual mortality. The incidence of SCC in patients with chronic perianal HS is 3.2%. This relatively high incidence specially in perianal HS most likely reflects the fact that patients do not always seek treatment and diagnosis can be challenging, leading to a late diagnosis of perianal disease. Due to the increased morbidity and mortality, the final diagnosis should be confirmed with the surgical pathology, and SCC should be kept in mind in patients with longstanding severe HS. Rarely perianal HS can extend to sacrum. In such cases management can become challenging and requires multidisciplinary approach including colorectal, spine/orthopedic and plastic surgery.

F. HS is a chronic, relapsing disorder that requires long-term treatment. Management depends on the disease stage and patient preferences. Warm compresses and topical cleaning agents can be used to relieve pain and clean affected areas in early lesions. Life style modifications including weight loss, smoking cessation and diet modifications might benefit patients with Hurley stage I. Patients with Hurley stage I and II are candidates for medical treatment. Topical antibiotherapy with Clindamycin has shown to reduce the number of lesions in patients with Hurley I and mild II disease. Systemic antibiotherapy with tetracycline or clindamycin-rifampin regimens are usually suggested for widespread and severe disease. Combination therapy with clindamycin and rifampin has shown to decrease patient Sartorius scores with a partial or complete improvement of HS. Many studies have reported clinical improvement with adalimumab (a fully human, IgG1 monoclonal antibody specific

for TNF-α) and infliximab (a chimeric human, IgG1 monoclonal antibody specific for TNF-α) in patients with moderate to severe disease, but some found no benefit. Recently published results of two Phase 3 trials (double blind, placebo-controlled periods) showed that adalimumab use for moderate to severe HS improved clinical response by week 12 when compared to placebo. It is important to note, however, that none of the patients enrolled in those studies achieved a complete response after adalimumab treatment. Recurrence rates ranges from 43% to 71% during long-term follow up after infliximab and adalimumab use, respectively. The immunosuppressive nature of these medications requires a comprehensive assessment before treatment to prevent possible infectious complications. Other treatment options including cyclosporine & tacrolimus (Calcineurin inhibitors, immunosuppressive), anakinra (IL-1 inhibitor), methotrexate (immunosuppressive), azathioprine (purine antagonist-immunosuppressive), colchicine (anti-inflammatory) and ustekinumab (IL-12/23 inhibitor) have not been studied extensively, and further randomized clinical trials are needed.

There are no consistent clinical data to support the use of retinoids (Vitamin A derivate; isotretinoin, acitretin) as monotherapy in the management of HS.

G. Different surgical procedures are available for patients with disease resistant to medical treatment or those for with recurrent disease. Patients with widespread disease (Hurley stage III) should also be evaluated for surgical resection. Local incision and drainage can be used to relieve pain in acute disease with little benefit in long-term management due to high recurrence rates. In patients with sepsis and abscesses, antibiotherapy accompanied by abscess drainage should be considered prior to definitive surgical treatment. Unroofing and scanner-assisted carbon dioxide laser therapies are good options for patients with recurrent lesions in fixed areas to preserve healthy tissue around the lesions. They can be performed in an office setting under local anesthesia and are associated with recurrence rates of 29% (363 operations in 113 patients) and 11.8% (34 patients), respectively. Local excision and primary closure is another option for patients with mild to moderate disease (Hurley stage I-II). The main principle is to achieve disease-free margins to reduce the recurrence rate after surgery. Reported recurrence rates ranges from 15% to 69.8% % in the operative field and surrounding fields. In advanced disease—Hurley stage III disease—radical wide excision of affected skin and subcutaneous tissue to fascia level is the only curative treatment Fig. 21.3b–d. Excision can be followed with subsequent secondary healing, flap creation or skin grafting. Skin grafting over granulation tissue can be performed in patients with large defects. Flap creation—usually in the perianal area—expedites the healing process. In these advanced cases, excising as many apocrine glands as possible has been reported to lower the risk of disease recurrence. Recurrence rates after radical excision ranges from 0% to 38% in the literature. Risk factors for recurrence after surgical management of HS are identified as young age, multiple surgical sites, and incision and drainage-type procedures.

The authors prefer local excision and secondary healing with daily packing, Sitz baths and daily showers in patients with anal HS. If secondary healing cannot be achieved after granulation tissue (Fig. 21.3e) is formed, skin grafting can be planned with plastic surgery. In cases where deep defects occur after resection of the perianal HS lesions or SCC large pedicle flaps can be created to close the defects. Routine fecal diversion in patients with severe perianal HS has been reported in the literature but this practice has not been widely accepted. Diversion should be considered in non-compliant patients with anal HS and/or in patients who are not fully mobilized due to comorbid conditions.

In addition to painful and extensive skin lesions, patients might also suffer from depression and sexual dysfunction. Decreased quality of life due to pain, draining lesions,

Fig. 21.3 This series of images show the surgical management of a patient with Hurley II perianal HS. (**a**–**d**) operative images when patient was positioned in the modified lithotomy position during operation. Image **e** was taken while patient was positioned in knee-chest position during follow up appointment at 2 weeks after excision. Healthy healing process with granulation tissue can be observed

disruption of self-respect and interpersonal relationships is not always well recognized by the caregivers, which might negatively affect patient compliance and overall outcome. Patients should be offered mental wellness and psychological support if needed.

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22 Anal Conditions: Anorectal Trauma

David M. Schwartzberg, Mitchell A. Bernstein, and Alexis L. Grucela

Refer to Algorithm in Fig. 22.1

A. Anorectal trauma is associated with blunt and penetrating injuries. Gunshot and seatbelt injuries are common to the colon and, despite improvements in critical care, continue to yield a septic complication rate of 20%. Anorectal injuries are not subject to the same treatment algorithms of colon trauma, mostly because of the bony confines of the pelvis. Blunt injuries to the pelvis are associated with a 2% rate of rectal injuries in pelvic fractures, and penetrating trauma (gunshot and stab wounds) accounts for >80% of rectal injuries. Because the intraperitoneal rectum is only 6–8 cm from the anal verge, intraperitoneal injury in anorectal trauma must always be considered, especially with foreign body insertions. As with any trauma algorithm germane to anorectal trauma, the two primary objectives are to control bleeding and limit contamination.

B. A thorough history of the incident is needed with description of the nature of the trauma (Fig. 22.2).

C. Identification of injuries must start with inspection of the perineum, perianal skin, and adjacent organs (vagina and scrotum) followed by assessment of blood in the rectal vault and anal tone with a digital rectal examination. Rigid proctoscopy should be performed and can accurately diagnose up to 95% of extraperitoneal rectal injuries.

D. Contrast enema has a role but is largely subjective. Plain x-rays of the chest, abdomen and pelvis are needed to assess for pneumoperitoneum and/or placement of a foreign body (Fig. 22.3). Triple-phase contrast computed tomography (CT) may also help assess the extent of the injury and indicate if it involves the genitourinary system (occurs at a frequency of 30–64% with rectal injury).

E. If the index of suspicion is high for intraperitoneal injury, or the patient has signs of peritonitis, a laparotomy or diagnostic laparoscopy must be performed. Prior to making a colotomy to extract a foreign body, manipulating it into the rectum for assisted transanal excision is encouraged if possible. If not possible, a longitudinal colostomy is made which is then closed transversely.

F. For foreign body insertion trauma, a thorough inspection of the mucosal surfaces and sphincters must be performed.

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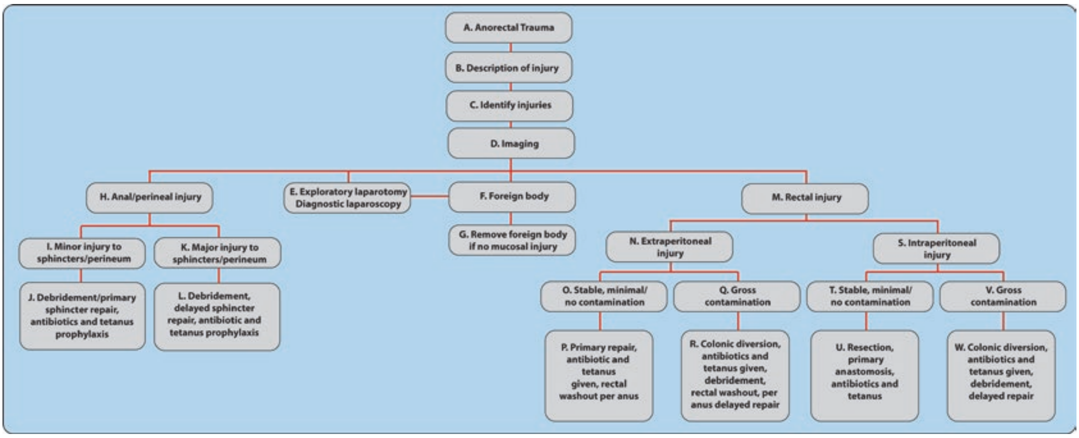

Fig. 22.1 Algorithm for evaluation and management of Anorectal Trauma

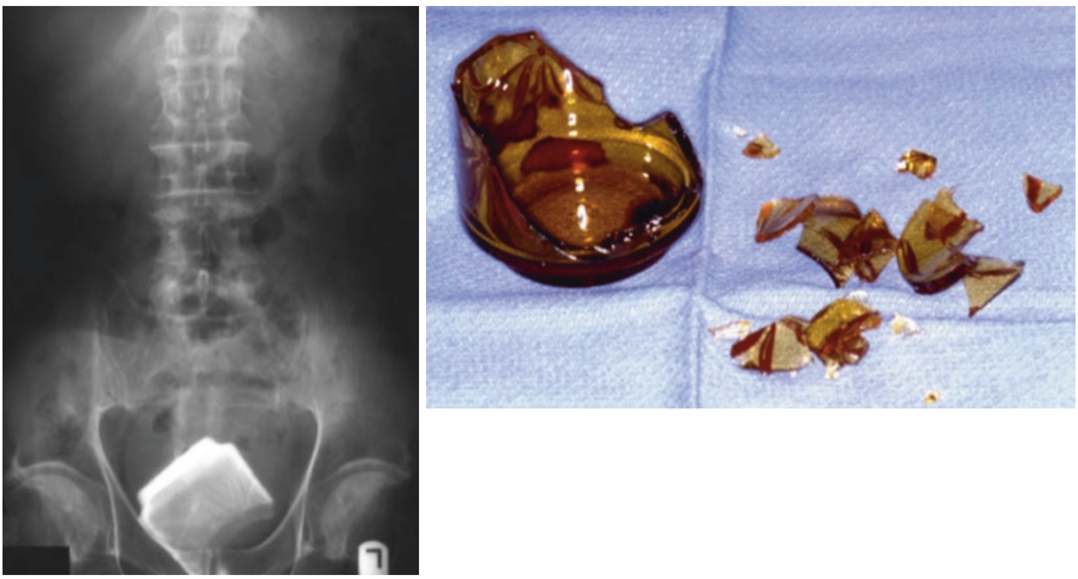

Fig. 22.2 Broken glass in the rectum, representing the importance of a thorough history of the incident to predict treatment plans. Courtesy of Dr. R. Steinhagen

G. The foreign body may be removed with sedation and nerve block, epidural or general anesthesia. If the index of suspicion is high for intraperitoneal injury or the patient has signs of peritonitis, a laparotomy or diagnostic laparoscopy must be performed (Fig. 22.4).
H. For anal or perineal injury, assess the anus, perineum and sphincter for damage.
I. For minor perineal and sphincter damage:.
J. Wide debridement, primary sphincteroplasty, tetanus and antibiotic prophylaxis against aerobic and anaerobic bacteria are sufficient.
K. For major sphincter and/or perineal damage.
L. Wide debridement of non-viable tissues is needed with a delayed sphincteroplasty. An exploratory laparotomy or diagnostic laparoscopy is needed to assess intraperitoneal injury and to perform a diverting sigmoid colostomy (loop or end-colostomy with

Fig. 22.3 Showing the importance of imaging to aid in determining operative versus non-operative treatment strategies to remove a foreign body

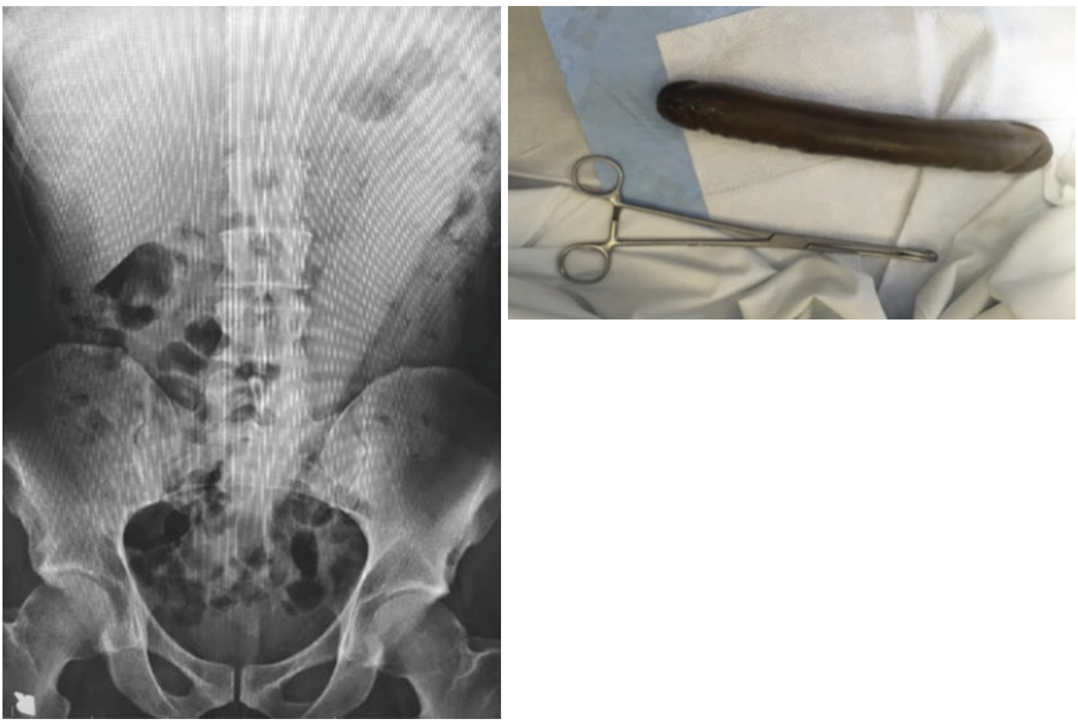

Fig. 22.4 Foreign body removed under sedation via a transanal route, after pneumoperitoneum was ruled out on imaging

mucus fistula). Therapeutic antibiotics are indicated along with tetanus prophylaxis.

M. Rectal injuries should be assessed with a digital rectal exam and rigid proctoscopy. CT imaging may be helpful.

N. For extraperitoneal rectal injuries: assess contamination.

O. For extraperitoneal rectal injuries without contamination.

P. Closure of the wound may be possible if contamination is minimal. Rectal irrigation per anus, prophylactic antibiotics and tetanus prophylaxis are necessary.

Q. For extraperitoneal rectal injuries with contamination.

R. A diverting colostomy with mucous fistula is created and distal rectal irrigation via the mucus fistula is not advised as it can cause

elicit intraluminal soiling of the pelvis. Rectal irrigation per anus is needed, along with prophylactic antibiotics and tetanus administration. Although they have not been shown to reduce infections complications, presacral drains can be considered and brought out through separate stab incisions, followed by reassessment and possible primary closure 3–5 days postoperatively.

S. For intraperitoneal rectal injury, a digital rectal exam and rigid proctoscopy are needed along with an exploratory laparotomy or diagnostic laparoscopy.

T. For an intraperitoneal rectal injury in a stable patient without gross contamination.

U. Resection and primary anastomosis, prophylactic antibiotics and tetanus administration. Oversewing of gunshot wounds is not recommended as bullets cause heat destruction of surrounding tissue making it inadequate for suture placement.

V. For an intraperitoneal rectal injury with gross contamination.

W. Proximal diverting ostomy, prophylactic antibiotics and tetanus administration, and debridement of non-viable tissues. Presacral drain placement has not been found to reduce infectious complications.

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Anal Conditions: STDs

23

Cindy Kin

Refer to Algorithm in Fig. 23.1

Anal Conditions: Sexually Transmitted Diseases

A. Screening for asymptomatic high-risk patients: Patients at high risk for contracting sexually transmitted diseases include men who have sex with men (MSM), anyone in high-risk sexual networks including prostitutes and swingers, and anyone with a current sexually transmitted disease. These patients should be universally tested for chlamydia and gonorrhea annually at anorectal, oropharyngeal, and urogenital sites (Fig. 23.1).

B. Screening and management for symptomatic patients (Fig. 23.1)
   (a) Perianal and/or genital lesions: Patients presenting with perianal or genital lesions are often misdiagnosed with fistulas, abscesses, hemorrhoids, or pruritus ani. Painful genital or perianal lesions in young sexually active patients are most likely due to infection with herpes or syphilis. Serologic testing for syphilis and HIV, and HSV culture or PCR should be performed. Empiric treatment should be started for the most likely pathogen. Painless lesions are likely to be condyloma. Pruritus lesions may be due to molluscum contagiosum.
   (b) Proctitis: Patients presenting with anorectal pain, tenesmus, and discharge should undergo testing for gonorrhea, chlamydia, syphilis, and herpes. Proctoscopy may not be possible due to patient discomfort, but intra-anal swabs should be taken before doing a rectal exam with lubricant. Empiric treatment for gonorrhea, chlamydia, and herpes simplex virus should be started, as well as symptomatic management with topical anesthetics and stool softeners.

C. Gonorrhea: Symptoms of gonococcal infection include dysuria, anorectal pain, anal discharge, or tenesmus. Nucleic acid amplification tests (NAATs) are recommended by the Centers for Disease Control (CDC) for detection of gonorrhea, except in cases of potential treatment failure in which cultures are required. Routine screening of all sexually active MSM and other high-risk populations at oropharyngeal, anorectal, and urogenital sites is recommended. Uncomplicated gonococcal infections should be treated with one intramuscular dose of ceftriaxone 250 mg, plus either one oral dose of azithromycin 1 g or a 7-day course of oral doxycycline 100 mg twice daily. Re-testing for gonorrhea should be performed at 3 months, and any sexual partners from the preceding 2 months should

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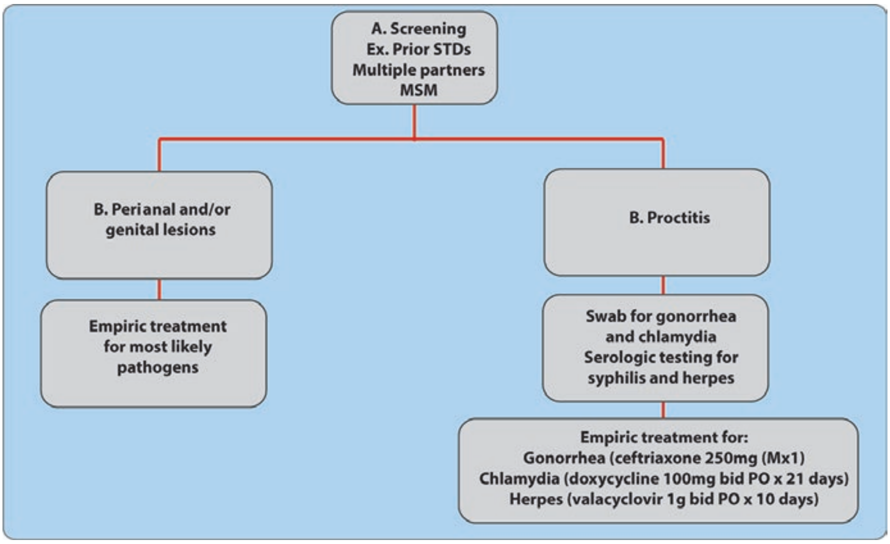

Fig. 23.1 Algorithm for testing and empiric treatment for symptomatic STDs (A&B); *MSM* men who have sex with men

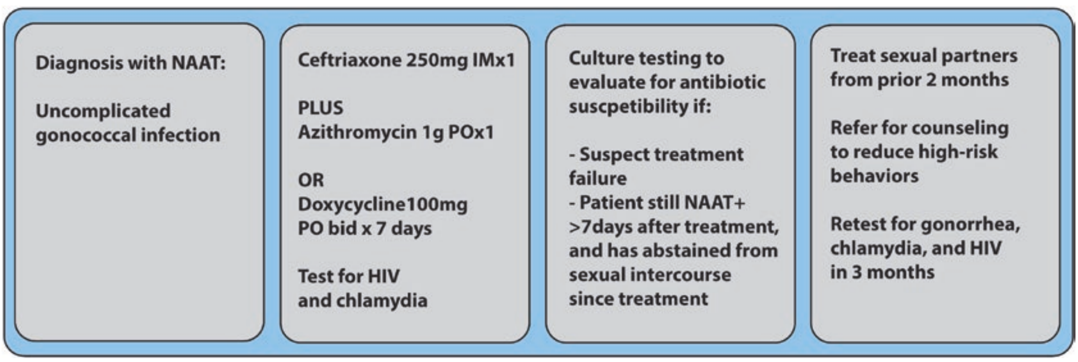

Fig. 23.2 Management of gonococcal infection (C); *NAAT* nucleic acid amplification test

also undergo empiric treatment. Chlamydia and HIV testing at the time of gonorrhea detection and 3–6 months later should also be performed (Fig. 23.2). Suspected treatment failures require culture for antimicrobial susceptibility testing, and confirmed treatment failures must be reported.

D. Chlamydia: As most infected patients are asymptomatic, screening of high-risk patients is critical to control this infection, which can cause the sequelae of pelvic inflammatory disease including infertility, chronic pelvic pain, and ectopic pregnancy. The CDC recommends NAATs using first catch urine or urethral swab for men, vaginal swab or endocervical swab for women, and also rectal and oropharyngeal specimens. Screening should be performed in sexually active women 24 years of age and younger, as well as high-risk older women. Screening may also be considered for high-risk men, which includes men in STD clinics, National Job Training Programs, juvenile detention facilities, the military, jail, men with infected partners, and MSM reporting anoreceptive intercourse. Treatment is a single oral dose of azithromycin 1 g, or a 7-day course of doxycycline 100 mg twice a day. Patients should be counseled against engaging in sexual intercourse for a minimum of 7 days after treatment, and

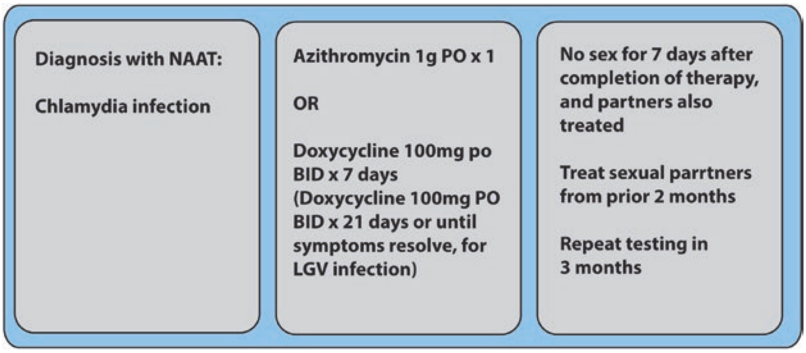

Fig. 23.3 Management of chlamydia infection (D); *NAAT* nucleic acid amplification test; *LGV* Lymphogranuloma venereum

until after their partners have also been treated. Sexual partners from the prior 2 months should also be tested (Fig. 23.3).

E. Lymphogranuloma venereum is caused by *Chlamydia trachomatis* serovars L1, L2, and L3, and presents with severe inflammation which can manifest as unilateral painful inguinal or femoral lymphadenopathy (buboes), genital ulcers, ulcerative proctocolitis or proctitis, or systemic constitutional symptoms. Untreated LGV may have serious sequelae including fistulas, strictures, infertility, pelvic fibrosis, and elephantiasis. The treatment is doxycycline 100 mg PO bid for 3 weeks. Buboes may require drainage. Sexual partners from the prior 2 months should be treated.

F. Syphilis, (Fig. 23.4) caused by *Treponema pallidum,* has experienced a resurgence among young men, MSM, black men, and Hispanic men. It can present as a solitary nontender genital chancre, multiple chancres, or proctitis. Screening is performed with nontreponemal tests (VDRL and RPR); if this is positive, then a confirmatory treponemal test should be performed. All sexually active MSM and all patients with HIV should be screened at least annually for syphilis. Treatment is a single intramuscular dose of penicillin benzathine 2.4 million units (Table 23.1). Sexual contacts should be treated empirically. Repeat testing should be performed at 6 and 12 months after treatment.

G. Chancroid, caused by *Haemophilus ducreyi*, causes multiple painful purulent genital ulcers with regional lymphadenopathy and bubo formation. It is diagnosed based on symptoms and by ruling out syphilis and Herpes. Treatment consists of one dose of ceftriaxone 250 mg intramuscular, one dose of azithromycin 1 g orally, ciprofloxacin 500 mg twice a day orally for 3 days, or erythromycin base 500 mg 4 times a day orally for 7 days.

Fig. 23.4 Syphilis caused by *Treponema pallidum*

H. Granuloma inguinale (donovanosis), caused by *Klebsiella granulomatis*, causes painless genital ulcers. Disseminated disease can cause cervical ulceration, pelvic lymphadenopathy, and septic arthritis; HIV-positive patients may experience malignant transformation. It is diagnosed with tissue smears that show Donovan bodies, or PCR. Treatment consists of three-week regimens of doxycycline, cipro-

Table 23.1 Management of syphilis infection (F)

	Treatment	Alternative treatment
Primary, secondary, early latent syphilis	Penicillin G benzathine 2.4 million units IM × 1	Doxycycline 100 mg PO bid × 2 weeks OR Tetracycline 500 mg QID × 2 weeks
Tertiary or late latent syphilis, syphilis of unknown duration, or relapse of syphilis infection	Penicillin G benzathine 2.4 million units IM weekly × 3 weeks	
Neurosyphilis, or patients co-infected with HIV and syphilis	Aqueous crystalline penicillin G 18–24 million units daily (given as 3–4 million units IV q4h, OR continuous infusion) × 10–14 days	

floxacin, erythromycin base, or trimethoprim/sulfamethoxazole.

I. Herpes simplex virus 1 and 2 both cause anogenital infection (Fig. 23.5), and 90% of those infected are unaware that they have it. Symptoms include painful vesicular ulcers and/or proctitis, and systemic symptoms especially with the first clinical episode. Cell culture, PCR, and serologic tests are available. Treatment with antiviral therapy (acyclovir, famciclovir, valacyclovir) can shorten the course of outbreaks, and suppressive therapy can be used in patients with frequent recurrences (≥4 per year) or in those whose sexual partners are negative for HSV.

J. Human papillomavirus infection may occur in up to 50% of sexually active individuals who are not vaccinated. Low-risk types are HPV 6 and 11 and cause genital warts; high-risk types are HPV 16, 18, 31, 33, and 35 and may cause high-grade dysplasia or squamous cell carcinoma of the anus, cervix, penis, vulva, and vagina. The risk for cancer is higher in immunosuppressed patients, especially in HIV-positive patients. Screening for high-grade dysplasia of the anus is performed with liquid-based anorectal cytology; positive or suspicious findings should be followed up with anoscopy or high-resolution anoscopy. Treatment options for external genital warts, anal canal warts, and high-grade dysplasia are detailed in Table 23.2.

Fig. 23.5 Herpes simplex virus

K. HIV infection may cause painful anal fissures and ulcers, and also predispose patients to cryptoglandular disease. Fistulas and abscesses in patients with AIDS should be treated with smaller incisions and drain or seton placement rather than large incisions. Screening for HIV antibodies should be performed in all patients presenting for STD testing. A nucleic acid test may be required to diagnose an acute HIV infection.

Table 23.2 Management of HPV related lesions (J)

External genital warts	**Patient-applied therapies:** Podofilox 0.5% solution or gel: apply bid × 3 days, then 4 days without therapy; can repeat cycle up to 4 times OR Imiquimod 5% cream: apply 3 times per week up to 16 weeks. Wash treated area with soap and water 6–10 h afterwards OR Sinecatechins 15% ointment: apply tid for up to 16 weeks **Provider-administered therapies:** Cryotherapy with liquid nitrogen or cryoprobe OR Podophyllin resin 10%–25% OR Trichloroacetic acid (TCA) or Bichloroacetic acid (BCA) OR Surgical fulguration or excision
Anal canal warts	Cryotherapy with liquid nitrogen OR Trichloroacetic acid (TCA) or Bichloroacetic acid (BCA) - can be applied weekly as needed OR Surgical fulguration or excision Consider high-resolution anoscopy to inspect for high-grade dysplasia
High-grade anal dysplasia	Consider high-resolution anoscopy with ablation and/or excision of aceto-white lesions

L. Molluscum contagiosum, caused by the Molluscipox virus, results in small, waxy, dome-shaped umbilicated papules that may become secondarily infected due to scratching of the lesions. Treatment consists of curettage excision and cryotherapy and should only be done in immunocompetent patients. Topical treatment with imiquimod 5% cream can be given to immunosuppressed patients.

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Anal Considerations: Fournier's Gangrene

24

Vanessa W. Hui and Rahul Narang

Refer to Algorithm in Fig. 24.1

The term "necrotizing soft tissue infection" (NSTI) is a fairly new clinical phrase coined in the 1950s to describe life-threatening infections leading to fulminant tissue destruction associated with sepsis and high death rates. Hippocrates first described the condition as early as 500 BC as a rapidly progressive bacterial infection that affects any soft tissue from any part of the body, causing cellulitis, myositis and/or fasciitis and associated gangrene. Generally, such infections are divided into two groups based on bacteriology. Type I NSTIs, responsible for 80–90% of all NSTIs, are a polymicrobial infection of mixed aerobic and anaerobic bacteria and more commonly affect patients with immunocompromise or those with chronic disease. Type II NSTIs are less common, occur more commonly in healthy individuals, and typically present as a more severe infection. They are usually monomicrobial (typically involving group A Streptococcus, *Aeromonas* in freshwater, or *Vibrio vulnificus* in seawater).

Fournier's gangrene (FG), most famously described by the eponymous French venereal dermatologist in the nineteenth century, is a NSTI that infects the perineum and/or external genitalia. Similar to most NSTIs, FG infections are polymicrobial, with *Streptococcus* and *Staphylococcus* as the main aerobic bacteria involved and with *Bacteroides fragilis* and *Escherichia coli* being the main contributing anaerobic counterparts. Recently, several case series have highlighted the emergence of monomicrobial infections with *Candida* as well as antibiotic-resistant organisms such as methicillin-resistant *Staphylococcus aureus*. Working in synergy, aerobes aggregate thrombocytes while anaerobes produce heparinase to activate localized blood vessel thrombosis, leading to ischemia, necrosis, and gangrene. Sources for FG-causing bacteria include the local skin flora and lower urinary tract, with those infections from the anorectum carrying a worse prognosis and a higher potential for death.

FG usually occurs in people ages 50–60. While it can occur in women, most population-based studies demonstrate that males are disproportionally affected at a rate of 10 to one and an increasing incidence with older age, plateauing to 3.3 cases per annum by age 50. Children are rarely affected. FG is only responsible for only 0.02% all hospital admissions. Though the mortality for patients with FG had ranged from 20–88% in cases series, recent pooled data from State Inpatient Databases suggest that it is lower at 5–16% per year, though this still remains a significant mortality rate.

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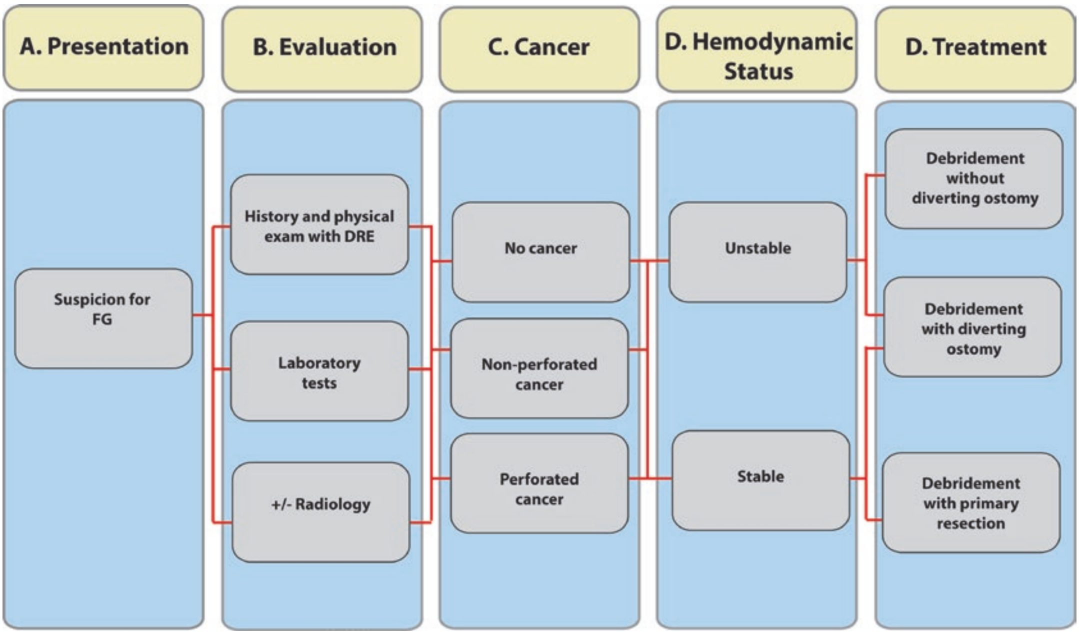

Fig. 24.1 Algorithm for management of Fournier's gangrene. Timely recognition and treatment for Fournier's gangrene (FG) begins with a suspicion as well as a combination of history and physical exam, laboratory tests, and/or imaging workup. If there is no cancer, timing of debridement depends on the hemodynamic stability of the patient, with the possibility of fecal diversion by ostomy. The management in the setting of cancer will depend on patient stability and the status of the cancer in regards to perforation

Risk factors for FG include baseline comorbidities such as diabetes, human immunodeficiency virus (HIV), leukemia, malnutrition and other conditions that can also lead to immunosuppression. Obesity and alcohol abuse have also been associated with an increased incidence of FG. Trauma, surgery, burns, and childbirth are potential inciting factors for FG.

Predictors for mortality include increasing age, hypertension, congestive heart failure, renal failure, and coagulopathy. A one-point increase in the Charlson comorbidity score has been associated with a 50% increase in mortality risk. Hospital admission requiring transfer to teaching hospitals has also been shown to increase the mortality rate and each procedure can potentially increase the patient's unadjusted odds of death by 27%. Both findings most likely reflect the true severity of the patient's disease process. Certain interventions also put patients at increased risk of death including need for mechanical ventilation, hemodialysis, colostomy, or penectomy. However, orchiectomy itself has been associated with a 70% decreased mortality risk. The Fournier's Gangrene Severity Index (FGSI) has been utilized as a prognostic indicator for survival (Table 24.1). Though initially developed from a small sample size, larger retrospective validation studies have demonstrated that this simple index has been highly reliable in predicting survival. A FGSI of eight or less has been associated with a survival rate of 96% while a score of nine or above has been associated with a 46% mortality rate.

Recognition is the key to commencing prompt and appropriate treatment for FG. Symptoms associated with FG may include a prodrome of fevers, chills, malaise, and fatigue. Findings on physical exam may include:

- Pain out of proportion to exam.
- Edema and/or tenderness beyond margin of erythema.
- Vesicles and/or bullae.
- Thin gray drainage.

Table 24.1 Fournier's Gangrene Severity Index (FGSI)

Physiological variable/point assignment	High abnormal values				Normal			Low abnormal values	
	+4	+3	+2	+1	0	+1	+2	+3	+4
Temperature (C)	More than 41	39–40.9	–	38.5–38.9	36–38.4	34–35.9	32–33.9	30–31.9	Less than 29.9
Heart rate	More than 180	140–179	110–139	–	70–109	–	56–69	40–54	Less than 39
Respiration rate	More than 50	35–49		25–34	12–24	10–11	6–9		Less than 5
Scrum sodium (mmol/L)	More than 180	160–179	155–159	150–154	130–149	–	120–129	111–119	Less than 110
Serum potassium (mmol/L)	More than 7	6–6.9	–	5.5–5.9	3.5–5.4	3–3.4	2.5–2.9	–	Less than 25
Serum creatinine (mg/100 mL, ×2 for acute renal failure)	More than 3.5	2–3.4	1.5–1.9		0.6–1.4		Less than 0.6	–	–
Hematocrit (%)	More than 60	–	50–59.9	46–49.0	30–45.9		20–29.9	–	Less than 20
White blood count (total/ $mm^3 \times 1000$)	More than 40	–	20–39.9	15–19.9	3–14.9	–	1–2.9	–	Less than 1
Serum bicarbonate (venous, mmol/L)	More than 52	41–51.9	–	32–40.9	22–31.9	–	18–21.9	15–17.9	Less than 15

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- Malodor.
- Crepitus.
- Cutaneous anesthesia.
- Ecchymosis and/or necrosis.

Several criteria have been used to distinguish NSTI from non-NSTI including the Laboratory Risk Indicator for Necrotizing Fasciitis (LRINEC) (Table 24.2). There should be a clinical suspicion for NSTI and FG if a score is greater than six, with a 92% positive predictive value. Imaging by plain radiography, ultrasonography, or computed tomography may be helpful in cases where a definitive diagnosis cannot be made on physical exam, as 90% of FG soft tissue infiltration has subcutaneous emphysema that may be visualized on radiography.

Serial surgical debridement remains the mainstay therapy and serves to eradicate all necrotic tissue that may potentially be a nidus for ongoing infection, along with the concomitant use of broad-spectrum intravenous antibiotics. Typical combination of antibiotics includes carbapenem or beta-lactam-beta-lactamase inhibitor with clindamycin for antitoxin effects against toxin-elaborating strains of *Staphylococcus* and *Streptococcus* with an additional antibiotic with activity against methicillin-resistant *Staphylococcus aureus*. As always, management of the sequelae of sepsis requires aggressive resuscitation with intravenous fluid and/or blood products and appropriate level of intensive care support. Adjunctive treatments to consider include hyperbaric oxygen to increase

Table 24.2 Laboratory Risk Indicator for Necrotizing Fasciitis (LRINEC)

Variable, Units	β	Score
C-Reactive protein, mg/L		
<150	0	0
≥150	3.5	4
Total white cell count, per mm^3		
<15	0	0
15–25	0.5	1
>25	2.1	2
Hemoglobin, g/dL		
>13.5	0	0
11–13.5	0.6	1
<11	1.8	2
Sodium, mmol/L		
≥135	0	0
<135	1.8	2
Creatinine, μmol/L		
≤141	0	0
>141	1.8	2
Glucose, mmol/L		
≤10	0	0
>10	1.2	1

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Final model constructed using factors found to be independently predictive of necrotizing fasciitis on multivariate analysis. β values are the regression coefficients of our model after adjusting for a shrinkage factor of .89. The maximum score is 13: a score of ≤6 should raise the suspicion of necrotizing fasciitis and a score of ≥18 is strongly predictive of this disease. To convert the values of glucose to mg/dL, multiply by 18.015. To convert the values of creatinine to md/dL, multiply by p0.01131

tissue oxygen tension and neutrophil function in order to inhibit the thrombotic effects of anaerobes, curb exotoxin production, and limit the degree of necrosis. Nutrition, preferably enteral, should be optimized in order to promote wound healing.

Fecal diversion may be necessary for severe perineal FG in order to minimize the ongoing bacterial contamination in the wound. Indications for fecal diversion include involvement of the anal sphincter as well as fecal incontinence. Diverting colostomies are more often necessary in patients whose FG originates from an anorectal source. The use of a colostomy should be judicious and highly individualized, as it has not been shown to improve overall survival. In addition, patients with ostomies typically suffer longer hospitalizations, higher financial burden from hospital costs, increased risk for abdominal wall hernia, and lower quality of life. Rectal tubes may be an adequate method for fecal diversion without the added burden of colostomies, with the caveat that they are a relative contraindication in those with colon or anorectal cancer, anorectal trauma, and anal fistula.

A. The anorectum is the most common origin of FG. However, anorectal cancer as the causative agent of FG is rare, encompassing only 0–3% of all anorectal-related FG. The management algorithm for anorectal cancers in the setting of FG depends on patient hemodynamics, the severity of FG, and the presence of a cancer-associated perforation (Fig. 24.1). Dependent on the location of the anorectal source and whether the anal sphincter is involved, the infection may have the potential to travel toward (1) the superficial fascia of the perineum to the scrotum and/or penis and superiorly along the anterior abdominal wall, (2) posteriorly into the presacral space and into retroperitoneum, or (3) into the ischiorectal fossa.
B. Pelvic imaging may be necessary to delineate the extent of debridement necessary to eradicate disease. While perforation is an indicator of cancer aggressiveness, it is difficult to determine whether cancer itself is a poor prognostic indicator for survival given the rarity of such cases.
C. At times, resection of the primary cancer, in the form of either a low anterior resection for upper to mid-rectal tumors or an abdominoperineal resection for low rectal cancers, at the time of debridement may be necessary in the setting of a frank perforation.
D. If an abdominoperineal resection is performed, the perineal wound should be left open. If primary resection is not technically feasible or if the patient is too hemo-

dynamically unstable, a colostomy during debridement may be adequate for disease control.

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25 Non-healing Perineal Wounds

Joshua H. Wolf and Martin Newman

Refer to Algorithm in Fig. 25.1

A. Patient history should be directed toward eliciting the various risk factors that have either prevented or arrested progression towards complete healing. Some of these factors may be subject to modification, including tobacco abuse, alcohol addiction, nutritional deficiency, and obesity. Inflammation is a normal and important phase of wound healing, and medications that attenuate the inflammatory process, such as steroids, immunosuppressive or anti-metabolic drugs may have a profound effect on wound progression. Modifiable risks should be reduced or eliminated. Patients should be counseled regarding the importance of smoking cessation and weight loss, and total nutritional support should be considered in cases of chronic malnutrition.

B. Certain *non*-modifiable attributes can also predispose patients to NHPW. The largest study of perineal wounds after APR to date, by Althumari et al. (reference listed in "Further Reading"), found that wound complications were associated with African American race, ASA class >4, smoking history, obesity, and chronic obstructive pulmonary disease (COPD). Other comorbid conditions that have been associated with poor wound healing include diabetes, inflammatory bowel disease (IBD), immunodeficiency and vasculopathy. While these comorbidities are not generally reversible, they should be aggressively controlled with medical treatment and specialty consultation.

C. Cellular injury due to radionecrosis, burns or pressure sores will significantly impede healing, and may ultimately lead to ulceration and necrosis. Radiation injury in the form of radionecrosis is unique in that the injury may be both delayed (6 weeks after exposure) and then progressive over time. Pressure ulceration in the perineum occurs in bedridden or paraplegic patients, and may first compromise the tissue immediately overlying the ischium or sacrum. In many cases of cellular injury, tissue is scarred or malperfused in the areas surrounding the wound itself. This may limit the success of local rotational flaps and skin grafts. Non-viable tissue should be widely debrided and reconstructed with tissue from outside the zone of injury, i.e. a regional or free flap.

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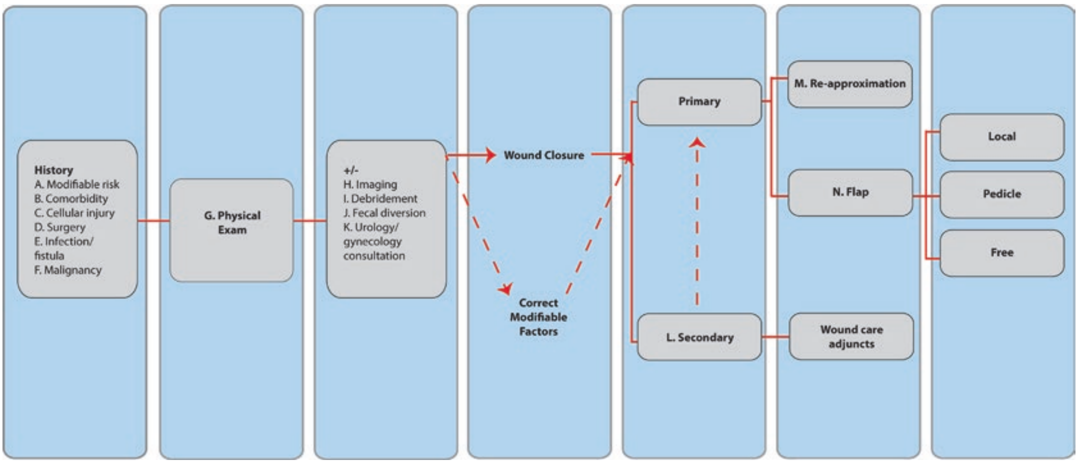

Fig. 25.1 Algorithm for management of non-healing perineal wounds

D. Perineal surgery often overlaps with one or several of the above risk factors. For example, abdominoperineal resection (APR) for rectal cancer may involve a radiated field from neoadjuvant treatment. Perianal surgery or APR in the setting of Crohn's disease can lead to scarring in an already malnourished patient on immunosuppressive therapy. The surgeon may wish to consider these additional factors when planning an operative approach. For example, it may be preferable to delay proctectomy and perineal closure in patients with Crohn's or mucosal ulcerative colitis and perform a staged procedure. If appropriate, intersphincteric dissection may help reduce wound size and improve closure integrity. Surgical positioning should be carefully considered as well, as some data have suggested higher rates of wound failure for patients positioned in lithotomy.

E. Infection must be definitely controlled to allow for wound closure. Fournier's gangrene is a polymicrobial necrotizing infection requiring aggressive debridement, broad spectrum antibiotic coverage and frequent dressing changes with Betadine or saline soaked gauze. Repeat debridement is often required to remove all nonviable tissue. Other infectious causes for NHPW include pilonidal disease and hidradenitis suppurativa, and management for both of these problems can be found in other chapters of this book.

F. NHPWs may also harbor malignancies in two distinct scenarios: (1) If the perineal wound is related to an already known malignancy, for example, an APR that was performed for Nigro-resistant or recurrent squamous cell carcinoma, then any delayed healing should prompt a high index of suspicion for recurrent disease. (2) Malignant transformation can occur in the absence of cancer history, arising de novo in chronically inflamed tissue. A firm plaque or fungating mass in a non-healing wound bed should raise suspicion and biopsy should be considered. However, the specific steps for diagnosis and treatment for soft tissue tumors of the perineum are beyond the scope of this chapter.

G. Physical examination of NHPW involves careful assessment of the following wound features:
   (a) Dimensions.
   (b) Structures involved (e.g., bone, muscle, soft tissue and skin).
   (c) Anatomic position.

(d) Presence or absence of infection.
(e) Quality of surrounding tissue.
(f) Involvement of urogynecological or neurologic structures.

Full evaluation requires a digital rectal examination in men and women, a vaginal and bimanual examination in women. There are often obstacles that prevent this from being done in the office, such as patient body habitus, pain and tenderness, need for multiple biopsies, or patient anxiety. In these scenarios the examination may be performed in the operating room under anesthesia at the discretion of the operating surgeon.

H. Imaging is not always critical, but it may often be helpful to exclude underlying processes such as abscess, fistulae, or bony involvement. Studies may include pelvic computed tomography (CT), magnetic resonance imaging (MRI), or fistulagram. Bone scans can be used to assist with evaluation of osteomyelitis. However, bone biopsy is often required to confirm the diagnosis.

I. Macrodebridement and microdebridement are two options for cleaning wounds in preparation for further healing and eventual closure. Macrodebridement involves surgical excision of nonviable or infected tissue back to healthy-appearing bleeding edges, and removal of any fibrinous debris. Depending on the degree of involvement, this can be accomplished at the bedside or in the operating room under anesthesia. Microdebridement refers to the use of regular wet-to-dry dressing changes, which help remove fibrin and stimulate growth of fresh granulation tissue.

J. Fecal diversion may be appropriate in cases in which microdebridement or secondary healing will likely be impeded by contamination. Examples include complex perianal fistulae (watering-can perineum), perineal wounds in patients with baseline fecal incontinence, or large or complex wounds immediately adjacent to the sphincter complex.

K. Urology/gynecology consultation can be helpful when fistulae to these respective organ systems have been demonstrated on physical examination or imaging.

L. Based on a variety of clinical, psychological and social factors a course of healing by secondary intention may prove the best options in some cases, for example, if the patient is a poor surgical candidate. Healing by secondary intension may also be the appropriate choice for wounds that are too large for primary closure, or that contain persistent contamination requiring serial macrodebridement. It should be noted, however, that healing by secondary intention can be a very lengthy and labor intensive/resource fueled endeavor. Thus, a variety of adjuncts have been developed to expedite the process. Moist wound dressings include alginate, silicone or polyurethane foam or beads, or hydrocolloid dressings. There are mixed data regarding superior healing for any of these techniques over gauze dressings, though foam dressings have been shown to improve patient comfort. Antimicrobial applications such as Betadine, Medihoney, petroleum or silver sulfasalazine are used to theoretically help reduce contamination. Negative-pressure wound dressings (NPWD) have been credited by many as helpful in promoting granulation and eventual re-epithelialization. The data on hyperbaric oxygen therapy is mixed but leans towards having an overall beneficial effect on wound healing in certain cases. Bioelectric treatments and stem cell-based therapies remain experimental.

M. Direct primary closure for NHPWs can be attempted once the wound is clear of infection and necrosis. Re-approximation is an option if there are healthy appearing skin edges that approximate without tension.

N. For deeper, more complex NHPWs that are not amenable to direct re-approximation, flap closures can be considered. Flaps can be broadly categorized by proximity to the wound, and the strengths and weaknesses of each subtype are reviewed in Table 25.1.

Table 25.1 Categorization of flap subtypes

Flap type	Vascular pedicle	Advantage	Disadvantage
Local	Random blood supply	Avoids donor site morbidities that accompany regional and free flaps Simple to design and execute	Broad application restricted by limited bulk and need for excellent tissue quality surrounding wound
Regional			
Gracilis	Medial femoral circumflex artery	Minimal functional morbidity, avoids abdominal incision	Small skin paddle and limited tissue bulk
Gluteus maximus	Inferior or superior gluteal artery	Minimal functional morbidity, avoids abdominal incision	Limited arc of rotation
Rectus abdominis	Deep inferior epigastric artery	Large tissue bulk	Risk of incisional hernia at donor site, obliteration of potential future stoma site
Omental	Right or left gastroepiploic artery	Large tissue bulk	Laparotomy or laparoscopic harvest required, no skin paddle
Free			
Anterolateral thigh	Descending branch of lateral femoral circumflex artery	Minimal functional morbidity, avoids abdominal incision	Only moderate bulk Significant anatomic variability Time consuming and technically demanding

(a) *Local flaps* generally refer to the transposition—in one form or another—of adjacent skin and subcutaneous tissue into the wound bed and are based on—most often—a random blood supply. A rotational flap is a commonly employed example. Local flaps are usually acceptable if the surrounding tissue is well perfused, not scarred or fibrotic, and has not been exposed to radiation. Tissue must be easily transferable without tension. This type of flap differs significantly from the others that will be discussed because the vascular pedicle is not specifically isolated.

(b) *Regional flaps* are usually larger segments of tissue mobilized from their native tissue beds and imported to fill the defect in question. These flaps may include a combination of skin, subcutaneous tissue, fascia and muscle. However, pure muscle or simple fasciocutaneous flaps often are adequate. Regional flaps often involve careful preservation of the vascular pedicle. Thus, the native vessels supplying these flaps must have adequate length to reach the wound. Common regional flap options include gracilis, gluteus maximus, rectus abdominis myocutaneous flaps or omental pedicle flaps. Mobilization, transfer and final positioning of both a gracilis flap and vertical rectus abdominis myocutaneous flap (VRAM) are shown in Figs. 25.2 and 25.3, respectively.

(c) *Free flap closure* represents the top rung of the reconstructive ladder. Although free flaps are more technically demanding than the other options listed and are associated with significant donor site morbidity, they are uniquely capable of filling defects when all other options have been exhausted, An common example of such is the anterolateral thigh fasciocutaneous flap.

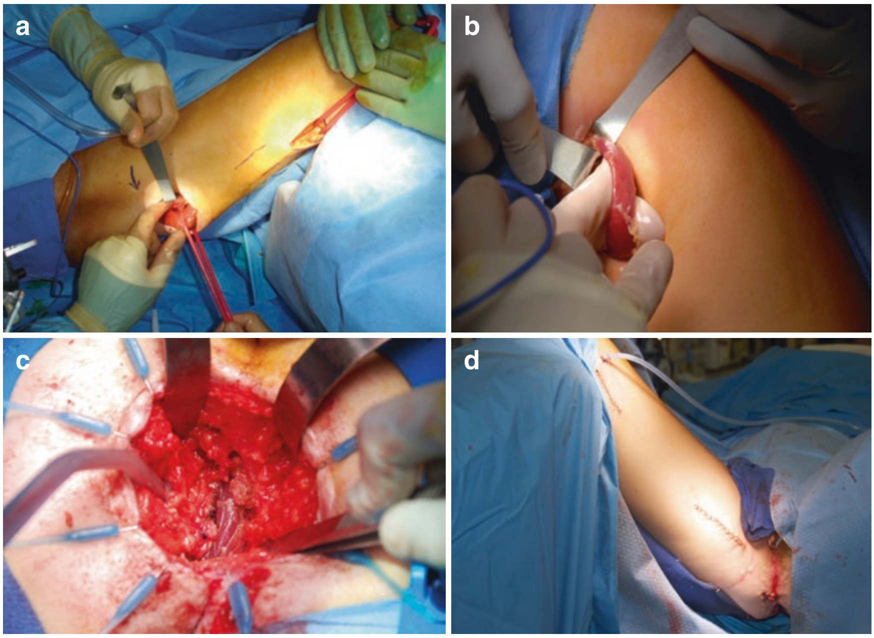

Fig. 25.2 Gracilis muscle flap harvest and transposition. The gracilis muscle is identified and mobilized through two incisions along medial thigh with care to preserve its vascular pedicle (**a** and **b**). It is then tunneled subcutaneously and transposed into the perineal defect (**c**). Final incisions are shown at case conclusion (**d**). (Courtesy of Dr. Steven D. Wexner)

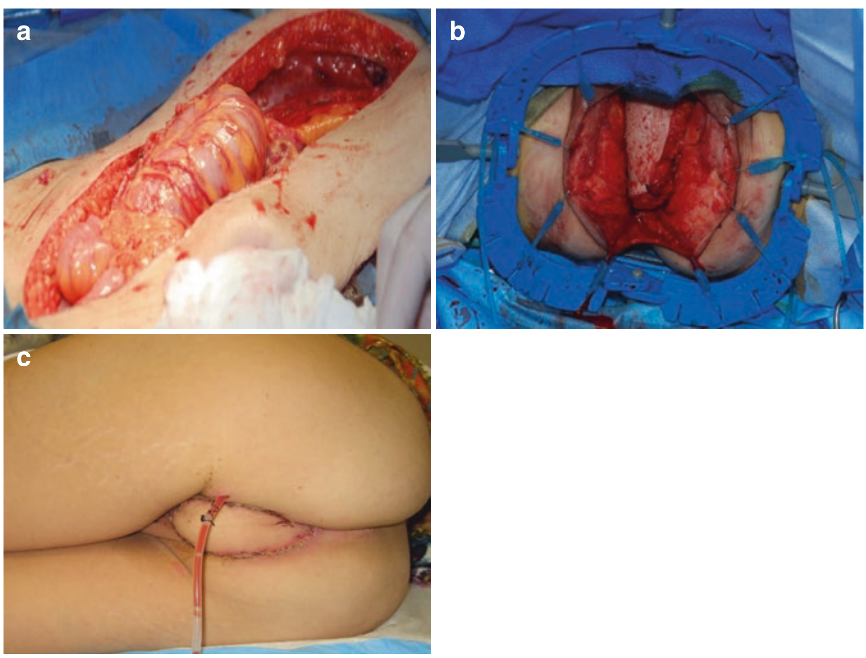

Fig. 25.3 Vertical rectus abdominis myocutaneous flap (VRAM). The rectus abdominis muscle is mobilized with a skin paddle (**a**) and brought into the perineal wound (**b**). The regional flap is perfused by the inferior epigastric artery. Final incisions and drain placement are shown at case conclusion (**c**). (Courtesy of Dr. Steven D. Wexner)

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26 Anal Intraepithelial Neoplasms

Alexis R. Harvey and Scott R. Steele

Refer to Algorithm in Fig. 26.1

A. Carcinoma of the anus is a relatively rare cancer, with an annual incidence less than 2/100,000, and the incidence has been rising at a rate of 2.2% each year, due largely to improved survival of persons with HIV. The National Cancer Institute estimates 8080 new cases and 1080 deaths will occur in 2016. Incidence is highest among white females and black men (2.1/100,000) and median age at presentation is 61 years. Five-year mortality is 66.4% overall but 80.7% if discovered while still confined to the primary site. According to the Centers for Disease Control, more than 90% of these malignancies are associated with human papillomavirus (HPV), primarily serotypes 16 and 18. Similar to HPV-related cervical cancers, anal cancer is preceded by a protracted pre-malignant dysplastic phase called anal intraepithelial neoplasia (AIN), supporting a role for routine screening in high-risk populations and early, targeted treatment and/or active surveillance when dysplasia is recognized. Vaccination against oncogenic strains of HPV can prevent anal cancer. Vaccination is most effective when administered before risk of HPV exposure, but there is evidence that post-exposure vaccination is also protective.

Risk factors for anal intraepithelial neoplasms include HPV infection, HIV seropositivity, history of anoreceptive intercourse, increased number of lifetime sexual partners, history of other HPV-related neoplasia (e.g., cervical intraepithelial neoplasia, cervical cancer), immunosuppression due to transplantation, and smoking. We recommend vaccination and annual routine screening by anal Pap smear (refer to section B in algorithm) in this population. A thorough patient history is critical to elucidate relevant risk factors. HIV+ patients must be compliant with HAART to benefit from HPV vaccination.

Routine screening is not recommended for persons not at increased risk but may be indicated based on clinical suspicion of AIN or anal cancer. In this population, normal cytology does not require additional follow up.

B. The anal Papanicolaou (Pap) smear is performed in the same manner as a standard cervical Pap smear. Advise the patient to refrain from anoreceptive intercourse and intra-anal enema or other preparation prior to examination. A small brush or Dacron swab moistened with water is inserted into the anus 2–3 in beyond the internal anal

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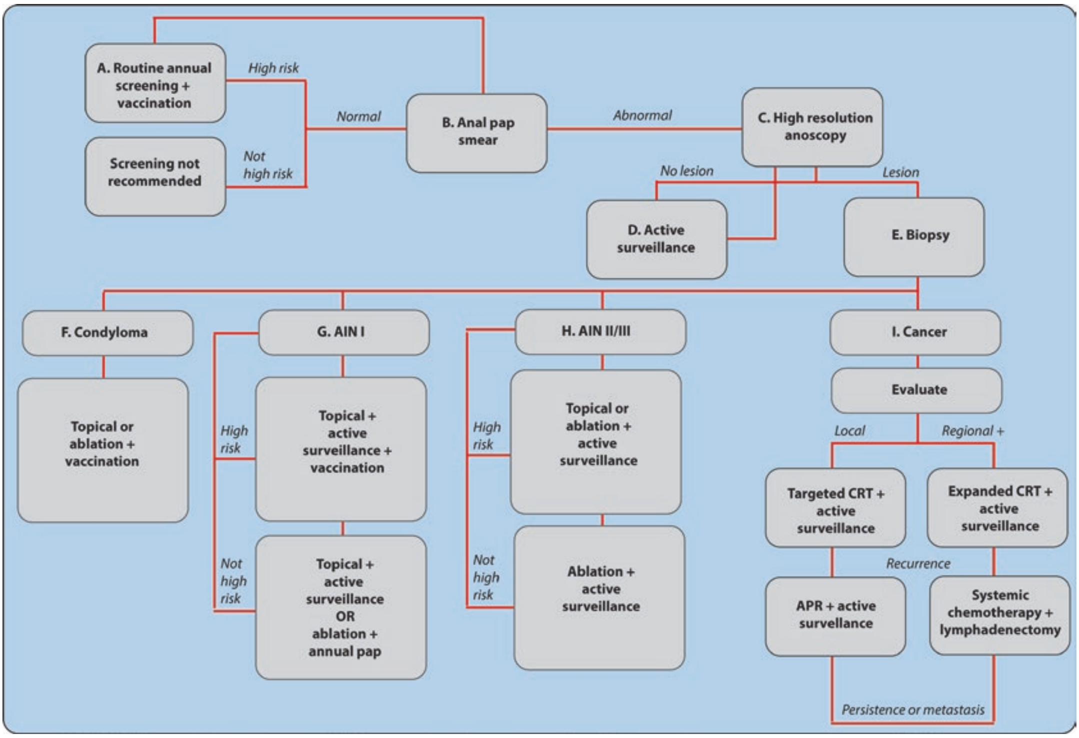

Fig. 26.1 Algorithm for treatment of anal intraepithelial neoplasms

sphincter and dentate line. Using firm lateral pressure, continuously rotate the swab 360° while withdrawing slowly from the anus. Sample collection should take 15–30 s, being sure to sample the entire anal canal, including the non-keratinized mucosa, the anorectal junction, and the keratinized anal verge. Fix and package the sample for transport according to the test manufacturer's specifications. Do not use a cotton swab or lubrication as they will interfere with the slide mount and interpretation. Deliver to a trained pathologist for interpretation. As part of a thorough physical examination, a digital rectal exam (DRE) should be performed to detect frank lesions.

Normal findings in high-risk individuals with no visually-apparent lesion or concerning symptoms (anal itching, bleeding, and/or pain) are referred for repeat screening in 1 year. Normal findings in persons not at increased risk do not require additional follow-up. Atypical results, regardless of risk factors, are referred for high resolution anoscopy (refer to section C in algorithm).

C. High-resolution anoscopy is used to visual dysplasia in vivo. Acetic acid (3%) turns acetowhite when applied to dysplastic tissue. Using an anoscope to access the anal canal, a gauze-wrapped cotton swabbed dipped in 3% acetic acid is placed in the canal and the anoscope is removed. After 1 min, the anoscope is reinserted and the cotton swab gently removed. A colposcope is used to magnify and thoroughly inspect the anal canal. If no lesion is found, the patient should be reexamined periodically (refer to section D in the algorithm). Dysplastic tissue that has turned white can be further investigated by applying Lugol's solution. Lesions that do not take up Lugol's solution are more likely to be a high-grade dysplasia. Reactive tissue

should be biopsied for diagnosis (refer to section E in algorithm). As part of a thorough physical examination, a digital rectal exam should be performed to detect frank lesions.

D. Active surveillance simply means serial examinations with high resolution anoscopy at regular periods to discover new lesions in at-risk individuals; to monitor changes in slow-growing lesions; or to catch recurrence in treated individuals. HPV is notoriously persistent because the virus can lie dormant in seemingly uninvolved tissue or be re-introduced in an individual that has fully cleared their infection. Furthermore, infection with one strain does not confer immunity against other strains.
   - Atypical cytology (section B) suggests exposure and/or increased risk even if a frank lesion is not apparent (section C). These patients should be re-examined by DRE and HRA every 3–6 months for several years (varies by institutional practices) prior to going back to the screening regimen once stable and free of disease.
   - Medically managed non-cancerous lesions require monitoring every 3–6 months to assess response to treatment or progression to a higher-grade lesion or to cancer. Monitoring should continue as long as dysplasia is appreciated, even if it is responding to treatment. Persistent or progressive lesions may require ablation. If lesion regresses, monitoring should continue every 3–6 months for recurrence as above.
   - High-grade lesions treated with ablation require active surveillance every 3–6 months for recurrence.
   - Cancers treated with chemoradiation or surgical resection require active surveillance every 3–6 months to look for persistence or recurrence in accordance with NCCN and ASCRS clinical practice guidelines.

E. Lesions discovered during HRA can be immediately biopsied using forceps and a scalpel. The small sample should be formalin fixed and sent to a pathologist for evaluation.

Diagnoses

F. Condylomata are epidermal growths caused by one of more than 30 distinct strains of HPV, though 90% are caused by strains 6 and 11. These strains are very unlikely to cause cancer, but history of condylomata is associated with exposure to other, some oncogenic, strains of HPV and potentially the development of cancer. All persons presenting with HPV condylomata can be treated with a topical agent or targeted destruction. They should also be offered vaccination to protect against future re-infection. High-risk individuals should continue annual screening for neoplasia.

   Topical treatments include 5% imiquimod cream and 5% 5-fluorouracil (FU) cream. Imiquimod is an immune modulator that acts to stimulate the body's natural immune system against the HPV infection. The cream is applied at bedtime three times per week for up to 16 weeks and washed off with soap and water the next morning. Imiquimod is not always curative, and may cause side effects—redness, irritation, induration, or ulceration—that are sometimes bothersome enough to affect patient compliance. Topical 5-FU blocks DNA replication, preventing a cell population from continuing to grow. It is used for 9–16 weeks with very good response rates. Targeted tissue destruction (ablation) using HRA-guided infrared coagulation may also be used. There is a high risk of recurrence with all of these treatments, further supporting the recommendation that high-risk individuals continue annual screening.

G. Anal intraepithelial neoplasia I (AIN I) is low-grade dysplasia and is believed to be caused by a transient, self-limited HPV infection that has a low chance of progressing to cancer. There have been several categorization schemes defined to characterize anal neoplasia. AIN I is synonymous with the early cytological designation of low-grade squamous intraepithelial lesion (LSIL) and the WHO's

classification of low-grade anal intraepithelial neoplasia (LGAIN). Despite the adoption of screening practices, AIN I is often discovered incidentally during an unrelated procedure. Note that AIN and cervical intraepithelial neoplasia often occur simultaneously, so women diagnosed should also be referred to a gynecologist for a thorough examination.

AIN I is unlikely to progress to malignancy, especially in immunocompetent patients and those not engaged in high risk behaviors; although the chance of progression is higher in immunosuppressed patients. These slow-growing lesions are best treated with topical agents and followed closely in active surveillance. Because of the risk of recurrence or re-infection, vaccination should be offered to these high-risk patients.

In persons who are not at increased risk, topical therapy and active surveillance (*i.e.,* "watch and wait") may be used or they may opt for targeted ablation and then follow up with an annual screening Pap smear.

H. Anal intraepithelial neoplasia II and III, intermediate- and high-grade neoplasia, are considered together. These designations are synonymous with high-grade squamous intraepithelial lesion and high-grade anal intraepithelial neoplasia. These lesions tend to be more persistent, more aggressive, and more likely to progress to malignancy. Treatment of them is only slightly more aggressive, however. High-risk individuals may choose the topical or targeted ablation with active surveillance. Those not at increased risk should be treated with ablation and also followed in active surveillance. Recurrence or persistence and progression are not uncommon in this group, so continued surveillance is critical.

I. Anal cancers may be of several histologic types, including cloacogenic, basaloid, epidermoid, and mucoepidermoid, but the majority are squamous cell carcinomas. While they together represent less than 2% of all colorectal malignancies, incidence is increasing and morbidity is high.

Anal cancers develop as a slow-growing mass within the anal canal as far as the anorectal junction, at the anal verge, or in the perianal region. Symptoms are present in 50% of cases and may include pain, bleeding, pruritus, irritation; 20% of cases are asymptomatic at presentation. Half of anal cancer patients present with localized disease, one-third with regional nodal involvement, and 10–15% with distant metastases. Most commonly involved lymph nodes are the inguino-femoral group and may cause groin pain.

A cancer diagnosis should prompt a complete physical exam including visual inspection, digital rectal exam, and lymph node investigation to confirm the disease and determine stage. The digital rectal exam can reveal location, fixation, and/or invasion. Palpate the groin for lymphadenopathy; perform a fine needle biopsy on suspicious nodes. Anoscopic or sigmoidoscopic biopsy may facilitate staging and enable assessment for concomitant colorectal neoplasms. A CT of the chest, abdomen, or pelvis should be ordered to evaluate lymph node involvement and regional spread. Consider a PET/CT if distant metastases are suspected. Stage according to the American Joint Committee on Cancer (AJCC) small cell cancer (SCC) staging criteria.

Local disease (confined to the primary site) and regional disease (lymph node involvement) are both treated with standard CRT and then followed with active surveillance as described below. Standard CRT includes mitomycin C (MMC) and 5-fluorouracil (5-FU) plus gamma radiation of the pelvic basin from L5/S1 to the perianal skin, including pelvic and inguino-femoral lymph nodes in the field.

Regional disease requires that the radiation field be expanded to include the area around he involved lymph node. Studies have shown that CRT has equivalent outcomes to the previous standard treatment—abdominoperineal resection (APR)—while preserving the sphincter function for the patient. Radiation alone is not recommended.

Cancer located at the anal margins present with bleeding, pruritus, and an ulcerated mass with rolled, everted edges. They are staged

similarly to anal canal cancers, except that state T4 denotes invasion of deep structures such as bone and muscle. Similar to other cancers, T4 anal margin cancer patients should have CT examinations to look for metastases (see Chap. 27). Preferred treatment is CRT; APR is recommended for deep lesions (T2-T4 or N1), those involving the sphincter muscles, or incontinent patients. Prognosis is poorer for cancers at the anal margin.

Local excision is considered only when the lesion is small, superficial, distal to the anal canal in either the anal margin, at the verge, or in the perianal skin. If margins are inadequate or there is suspicion that a small number of tumor cells were left behind, low-dose chemotherapy is warranted.

Post-treatment surveillance is critical as persistence and recurrence are common. However, active surveillance cannot begin until 8–12 weeks after completion of CRT. A complete physical exam includes visual inspection, DRE, HRA, inguinal node palpation. Patients should be examined every 3–6 months for the first 2 years and every 6–12 months until 5 years after treatment.

If the cancer is detected within 6 months of treatment, it is called persistent. Cancer detected past 6 months is considered recurrent. Persistence or recurrence after CRT occurs in 20–30% of patients and is associated with a higher stage at presentation, HIV seropositivity, and an inability to complete CRT. Persistent disease has a poorer prognosis than recurrent disease. If a local disease fails to respond to CRT, APR is recommended. Note that a rotational or pedicled flap should be used for reconstruction to decrease the chance of wound failure.

If salvage therapy fails for a local disease OR if CRT fails, systemic chemotherapy is indicated. In disease with distant metastases, cetuximab may prove helpful as an adjuvant therapy. Involved lymph nodes should be removed. Prognosis is poor in this subgroup, with a median survival of 9 months.

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27 Anal Conditions: Anal Margin Tumors

David A. Vivas and Jill C. Genua

Refer to Algorithm in Fig. 27.1

A. **Incidence**
Anal cancer is a relatively rare, uncommon malignancy. Worldwide, the incidence of anal cancer has been increasing over the past 3–4 decades, particularly in developed countries. The true incidence of anal margin cancer is difficult to determine, as lesions of the anal canal and anal margin are often grouped together. Anal margin cancer is at least five times less common than anal canal cancer. Generally, anal margin cancer is thought to follow a different clinical course with lower incidence, less aggressive biology, greater likelihood of local excision and a more favorable outcome.

B. **Definition**
The anal margin or perianal skin is identified by keratin containing epithelium containing hair follicles and encompasses a radius of 5 cm from the anal verge. The anatomy of the anus can be confusing; in addition, body habitus of the patient and distortion of the area due to the pathology can hinder precise localization. The distinction between the anal margin/perianal skin and the anal canal is important to avoid over or under treatment due to incorrect localization. The anal canal is divided into two regions: the anal canal proximal to the dentate line (columnar epithelium), and the anal canal distal to the dentate line (stratified squamous epithelium). The **dentate line** is defined as the demarcation between the columnar epithelium of the proximal canal and the stratified squamous epithelium of the distal canal. The **anal verge** is defined as the junction of the squamous epithelium with the perianal skin (anal margin) which is a keratinized squamous epithelium containing hair follicles. The anal margin is defined as the skin within 5 cm from the anal verge. In order to eliminate discrepancy between practitioners, a more practical description has been proposed. Upon retraction of the buttock, the anal canal is not visualized, the anal verge is the part of the anal canal that remains closed, and anal margin/perianal lesions are completely visible within a 5 cm radius of the anal opening. The dentate line also separates the pattern of lymphatic drainage; tumors below the dentate line and the anal margin drain into the inguinal and femoral lymph nodes.

C. **Types of anal margin tumors**
Anal margin tumors include squamous cell carcinoma (Fig. 27.2), Bowen's disease (perianal high grade squamous intraepithelial

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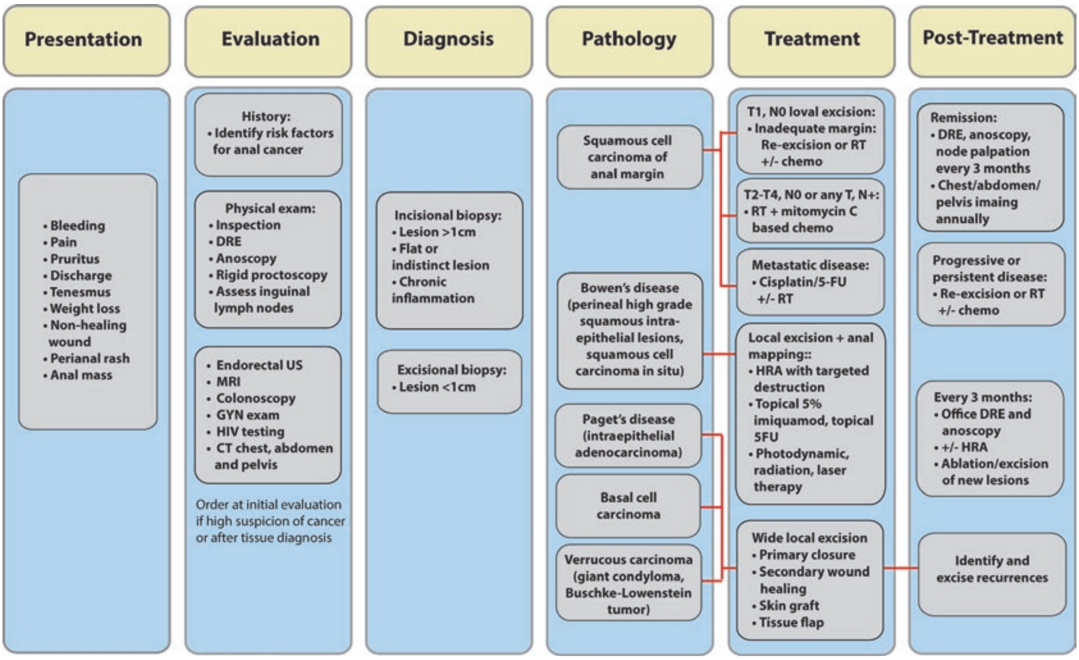

Fig. 27.1 Algorithm for diagnosis and treatment of anal margin tumors. *DRE* Digital rectal exam, *RT* Radiotherapy, *HRA* High resolution anoscopy, *APR* Abdominoperineal resection

lesions, squamous cell carcinoma in situ), Paget's disease (intraepithelial adenocarcinoma), basal cell carcinoma, verrucous carcinoma (giant condyloma, Buschke-Lowenstein tumor) and malignant melanoma. Of these, the most frequent tumor of the perianal skin is squamous cell carcinoma.

D. **Presentation**

The vast majority of patients presenting with anorectal complaints will have benign disease. Surgeons should evaluate these complaints thoroughly and consistently. Suspicious or atypical findings must be recognized on physical exam and promptly biopsied. Symptoms at presentation most commonly include anorectal bleeding, pain, pruritus, discharge, palpable mass/lump, tenesmus, weight loss, perianal rashes and chronic non-healing processes. History should identify the following risk factors: HPV infection, smoking, prior radiotherapy, Crohn's Disease, chronic anal wounds/drainage/fistulas, abnormal PAP smear, history of cervical carcinoma, immunosuppression following solid organ transplant, Hodgkin's Disease, HIV infection, sexually transmitted diseases, multiple sexual partners, male homosexuality, anoreceptive intercourse, immunosuppression, anal condyloma, and Anal Intraepithelial Neoplasia (AIN). A history of benign lesions does not contribute to the development of anal cancer. Physical exam includes inspection of size, location and features, digital rectal examination, anoscopy, rigid proctosigmoidoscopy, and inguinal and femoral lymph node palpation. Colonoscopy, vaginal exam/PAP, and HIV testing can be considered at this time or as the diagnosis evolves. Important descriptive features of the anal lesion include location, size, proximal extent, ulceration or central depression, pigmentation, and characteristics of the edges (discrete, rolled, indistinct). Note whether the tumor is friable, superficial, firm, flat, papillomatous or cauliflower like (Fig. 27.2).

Fig. 27.2 Large squamous cell carcinoma of anal margin. With minimal retraction of the buttocks, the lesion is seen beginning at anal verge and centered in the 5 cm radius, extending from the anal verge in the perianal region

E. **Diagnosis**

Diagnosis is determined by incisional or excisional biopsy depending on the size of the lesion and the likelihood of achieving adequate margins. Total excisional biopsy is recommended for lesions smaller than 1 cm or isolated mucosal findings; incisional biopsies are preferable for tumors larger than 1 cm. Excisional biopsy of large lesions or attempt to reduce the tumor burden at time of biopsy can lead to damage to the sphincter and should be avoided. Punch biopsy can assist with tissue biopsy of larger tumors, flat lesions, or indistinct areas of chronic inflammation. Excisional biopsy should include a 1 cm margin. Anal ultrasound and MRI may provide helpful information such as tumor size, location, sphincter involvement or extent of penetration into deep or adjacent tissue. Operative exam under anesthesia may be required to define the borders and obtain tissue for pathology, particularly if the tumor is bulky and invading the anal canal.

F. **Squamous cell carcinoma of anal margin/perianal skin**

Squamous cell carcinoma of the anal margin typically appears as an ulcerated lesion with rolled everted edges. The tumor starts as a slow-growing nodule confined in the perianal skin until later stages when the lesion may advance in to the anal canal. Once histology is confirmed as anal margin squamous cell carcinoma, CT of the chest, abdomen and pelvis is performed; colonoscopy, HIV status and gynecological exam in women are updated. The staging for cutaneous SCC is applied. T1 tumors are less than 2 cm, T2 are 2–5 cm or any tumor with high risk features, T3 tumors are greater than 5 cm in size and T4 tumors involve invasion of deep extradermal structures (bone, striated muscle, cartilage). Lymph node metastasis is related to tumor size: 0% in tumors less than 2 cm, 23% of tumors 2 to 5 cm and 67% of tumors greater than 5 cm.

a. T1N0 anal margin SCC can be successfully treated by wide local excision with a 1 cm margin around the tumor and if there is no sphincter involvement. T1NO and early T2N0 lesions can also be treated with primary radiation therapy. Generally, wide local excision is preferred for small, well differentiated tumors, which avoids the inconvenience and morbidity that can result from radiation therapy. If the margins are inadequate, reexcision can be performed or consideration is given for radiation therapy +/− 5-FU or capecitabine-based chemotherapy. Suspicious lymph nodes should be investigated with FNA or biopsy. Sentinel lymph node biopsy has been used for all T stages tumors for better treatment planning and to avoid unnecessary radiation in larger tumors but the results are too inconsistent to put this into routine practice. T2NO superficial, well to moderately differentiated anal margin squamous cell cancers can be treated with radiation alone to the primary lesion and the inguinal nodes. For

larger tumors (T3–T4) or any lymph node involvement (N+), external beam radiation to the primary tumor and inguinal/pelvic lymph nodes with 2 cycles of concomitant adjuvant chemo (5-FU/mitomycin or mitomycin/capecitabine) are given. Abdominoperineal resection (APR) is considered for significant sphincter involvement, tumors persisting after chemoradiation or salvage following local recurrence.

G. **Bowen's disease (perianal high grade squamous intraepithelial lesions, squamous carcinoma in situ)**

Bowen's disease was first defined in 1912 as a premalignant dermatosis of the perianal region that developed an invasive component in less than 5% of cases. The terminology to describe anal dysplasia has undergone changes. Bowen's disease is synonymous with high grade squamous intraepithelial lesion (HSIL), anal squamous carcinoma in situ, high grade anal intraepithelial neoplasia (HGAIN) and AIN II and AIN III. HSIL is the term most consistently used. HSIL is the immediate precursor to anal cancer with HPV related dysplastic changes as the causative agent. Appearance of HSIL may mimic dermatologic conditions appearing as a scaly plaque-like lesion, may be clinically unapparent, or may be detected incidentally such as in hemorrhoidectomy specimens. Goals of treatment should include eradication of primary and recurrent lesions, prevention of progression to cancer and minimizing morbidity. A variety of options exist with controversy as to which is superior. Traditionally, wide local excision and anal mapping to achieve negative histologic margins has been performed. This involves four quadrant biopsy of the anal canal, anal verge and perianal skin for 12–24 punch biopsies. These blind biopsies may heal by secondary intention, but if repeated biopsies are needed or the defects are large, then skin grafting or flaps would be required. An alternative is high resolution anoscopy (HRA) which involves identification of the HSIL using acetic acid, Lugol's solution and an operating microscope. HSIL is identified and targeted for destruction by electrocautery, laser or infrared coagulation. Common topical therapies include topical Imiquimod and topical 5-FU. Photodynamic therapy, radiation therapy, and laser therapy have been reported with some success. Although the preferred management of patients with HSIL varies, there is agreement that consistent follow-up, targeting excision or ablation of new lesions and patient compliance play an important role in preventing the progression of HSIL to invasive squamous cell cancer.

H. **Paget's disease (intraepithelial adenocarcinoma)**

Perianal Paget's is a rare intraepithelial adenocarcinoma, a precursor to invasive adenocarcinoma and a form of extramammary Paget's disease which develops in apocrine glands. Perianal Paget's usually presents as a slowly expanding, sharply demarcated, erythematous plaque that can be eczematous, crusting, scaling or ulcerated and causes pruritus, pain, burning and bleeding. As with many anal lesions, symptoms may be nonspecific, resulting in delayed diagnosis. Pathologic examination reveals Paget cells, which are malignant cells with enlarged, clear cytoplasm and large nuclei. Perianal Paget's disease presents as two entities: primary anogenital extramammary Paget's disease, or secondary to extension of a colorectal malignancy or to a remote gastrointestinal cancer. Approximately half of patients with anal Paget's disease harbor a colorectal neoplasm, therefore full colonoscopic examination is mandatory with this diagnosis. Treatment of noninvasive Paget's disease is local excision with clear margins. Preoperative or intraoperative mapping with random punch biopsies is often required to establish the boundaries of the lesion microscopically. The goal of excision is to achieve microscopic margins of 1 cm. A variety of techniques for staged excision and skin grafting have been described to minimize morbidity as an alternative to tissue flaps if the microscopic disease is circumferential or extensive. Invasive disease or peri-

anal Paget's disease with an associated invasive colorectal malignancy may require APR for radical resection, and/or combined modality with chemotherapy and radiation.

I. **Basal cell carcinoma**

Perianal basal cell carcinoma is a rare anal margin lesion and a rare site of cutaneous basal cell carcinoma. Full examination should be performed as patients often have basal cell carcinomas elsewhere in the body. It is typically a 0.5 to 5 cm nodular or ulcerated nodular lesion; superficially extensive and infiltrative patterns also occur. The risk of spread is low and complete excision is curative. For large perianal basal cell carcinoma, bilateral V-Y flap has been described for reconstruction of the perianal skin defect after curative resection. Deep invasion requiring radical resection with APR or local control would be extremely unusual. Basal cell carcinoma of the anal margin should be distinguished from basaloid squamous cell carcinoma of the anus which is a different pathologic entity.

J. **Verrucous carcinoma (giant condyloma, Buschke-Lowenstein tumor)**

Verrucous carcinomas (also known as giant condylomas and historically labeled Buschke-Lowenstein tumors) area lesions characterized by condylomatous features, large size, local invasion and lack of distant metastasis. They are associated with HPV, but a causal relationship has not been established. In the early clinical stages, they appear as verrucous, slow growing lesions, resistant or poorly responsive to topical therapy. Histologically they are benign: low grade, well differentiated, with minimal atypia and few mitotic cells. As they grow larger, the verrucous carcinomas invade the surrounding tissue causing destruction, necrosis and erosion. In this later stage, local tissue destruction may result in fistulas and extension into the ischiorectal spaces. Despite this malignant, invasive behavior, verrucous carcinomas do not metastasize. Biopsies of multiple areas, including the base of the tumor, should be taken to rule out a true invasive component which would then be viewed as invasive squamous cell carcinoma with metastatic potential. Treatment is wide local excision, preferably in the earlier stages. In the later fistulizing stages or if the tumor degenerated to an invasive squamous cell carcinoma, abdominoperineal resection (APR) may be necessary. Combined modalities such as chemotherapy and radiation are not used for verrucous carcinoma unless there is a true invasive component.

K. **Malignant melanoma**

Anorectal melanoma is rare and more likely to begin in the anal canal than the anal margin. However, anal melanoma may be diagnosed based on a symptom or finding at the perianal skin. Anal melanoma carries a dismal prognosis as the diagnosis usually occurs at an advanced stage. APR offers no survival benefit but is performed if bulky lesions cannot be locally excised, and to improve quality of life when tumors are responsible for local symptoms such as incontinence.

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28 Invasive Anal Canal Neoplasia

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Refer to Algorithm in Fig. 28.1

A. Anal cancer accounts for a small percentage (2.6–4%) of all lower gastrointestinal malignancies. There is a slight preponderance to females (incidence 2000 female, 1500 male), presenting most commonly in the sixth-seventh decade of life, with the most common presenting symptoms of bleeding (27–74%) and/or anal discomfort (21–39%), but up to 20% are asymptomatic. The anal canal is defined as the terminal part of the large intestine, beginning at the upper surface of the anorectal ring and passing through the pelvic floor to the anus". The "surgical anal canal" is defined as beginning at the puborectalis sling and extending to the anal verge/intersphincteric groove, as the anal margin is defined as the perineal skin baring skin appendages and outward for 5 cm.

B. A pertinent history and physical examination are essential as part of the evaluation, as questions should include constitutional symptoms, blood per rectum, sexual practices, smoking history, sexually transmitted diseases, genital warts and specifically a known history of HIV/AIDs or HPV infection. Physical examination should include inspection with anoscopy and proctoscopy, digital rectal exam with assessment of sphincter function, exact document of the tumor for location, occupying percentage of anal circumference, fixed or mobile, and size (as some lesions completely vanish in response to neoadjuvant treatment and for clinical T-stage) as well as a bilateral inguinal lymph node examination.

C. For pathologic diagnosis, one to two incisional or punch biopsies from the edge of the lesion should be performed, excisional biopsies should be avoided due to risk of sphincter damage or causing delay of C-XRT due to wound healing. Examination under anesthesia is often necessary since a thorough office exam is often precluded by patient discomfort.

D. Anal squamous cell carcinoma (SCC) is slightly more common in females and presents most commonly between the ages of 60–65 years old. Recently, anal SCC has had an increasing incidence in males who have sex with other men (MSM), and those with HIV infection. It is often diagnosed up to 24 months after the onset of symptoms, often because of prolonged treatment for benign conditions such as anal fissures or hemor-

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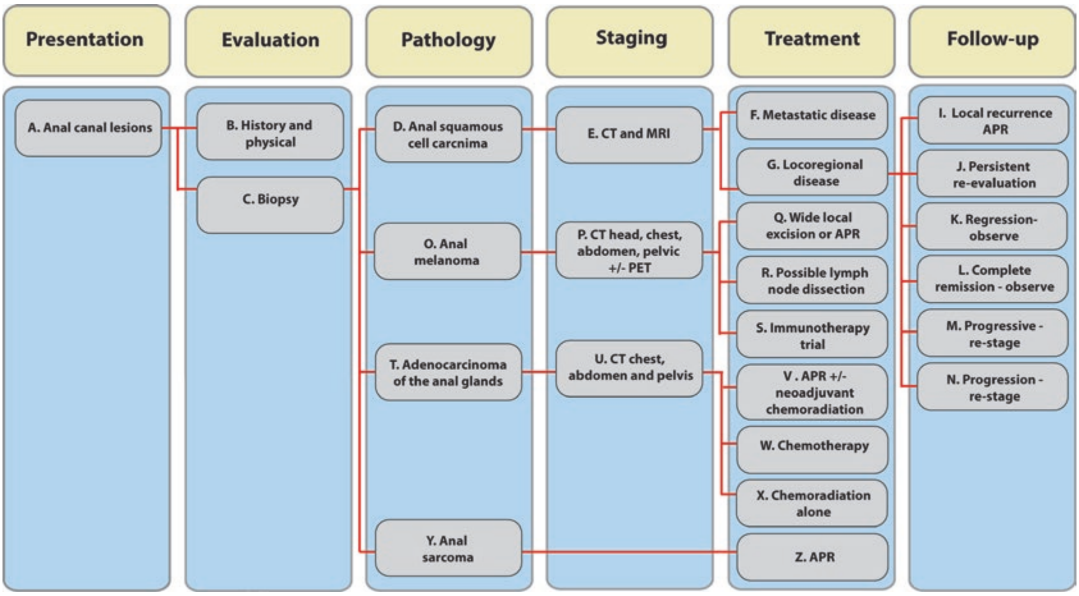

Fig. 28.1 Algorithm for invasive anal canal neoplasia. *APR* abdominoperineal resection

rhoids by general practitioners, which ultimately accounts for a large percentage of advanced disease at initial diagnosis. Forty-five percent of patients present with rectal bleeding, followed by anal pain or mass in 30%, followed by pruritus ani, fecal incontinence, anal fissure, and change in bowel habits.

E. Metastatic workup includes CT chest/abdomen with PO and IV contrast and pelvic CT or MRI with contrast. If available, FDG-PET/CT should be performed since anal SCC is 98% FGD avid and it has been demonstrated to identify metastases which were undetected by other imaging or physical exam in 17–25% of cases leading to a change of C-XRT plans in 5–19% of cases. Presence of neurologic symptoms should prompt CT head to assess for brain metastasis.

F. At presentation, 10–20% of anal SCC patients have distant metastasis. The most common sites are liver, lung, extrapelvic lymph nodes, bone and subcutaneous tissues. Median survival is 9 months. Metastatic disease should be treated with 5-FU (continuous infusion, 1000 mg/m^2/d IV days 1–5) and Cisplatin (100 mg/m2 IV day 2), repeat every 4 weeks. C-XRT should be considered for local control of symptomatic bulky primary disease.

G. Treatment for locoregional disease varies based on staging and location of disease burden. All stage patients receive C-XRT with Mitomycin-C (MMC) and 5-Fluorouracil (5-FU) tailored to tumor stage and location of lymph node involvement. For ≤T2N0 disease, an intermediate dose of radiation 42–45 Gy to the inguinal nodes, pelvis, anus, and perineum is given, but for T3/4 or N1 disease an additional boost of 9–14 Gy is given to the original primary tumor and involved nodes plus a 2–2.5 cm margin. The dosing and schedule is Mitomycin (10 mg/m2 IV bolus days 1 and 29)/5-FU (1000 mg/m2/d IV days 1–4 and 29–32)(or Capecitabine 825 mg/m2 PO BID, Monday–Friday and on each day radiation is given, typically 28 treatment days) and external beam radiotherapy (45 Gy in 1.8 Gy fractions 5 fractions for 5 weeks).

H. Regression of SCC is gradual after C-XRT so patients should be examined starting at 6–12 weeks after completion of neoadjuvant treatment with, digital rectal exam (DRE) and inguinal node palpation. Documentation

of the lesion, including size, mobility and inguinal nodal status is mandatory. The presence of a mass at this stage is not a mandate to perform a resection (unless the tumor progressed during treatment), as chemoradiation therapy has continued effects beyond completion of the treatment.

I. If a patient had a documented regression and subsequent complete clinical response, and biopsy proved SCC lesion is then detected on surveillance <6 months of completing C-XRT, it is defined as locally recurrent. If locally recurrent, the patient should undergo full staging work-up with PET-CT and biopsy of the lesion and any palpable nodes. If there is no distant metastasis, the patient should undergo abdominoperineal resection (APR) with inguinal node dissection for positive nodes, and myocutaneous flap is often required to close the perineal defect. For clinically negative nodal disease inguinal node surveillance every 3–6 months for 5 years, with cross-sectional imaging of the chest/abdomen/pelvis annually for 3 years.

J. Persistent disease is defined as locoregional failure within 6 months of C-XRT completion in patients without a full initial clinical response. For disease that persists after completion of C-XRT, the lesion should be followed and re-evaluated at 4 week intervals until 6 months following completion of C-XRT.

K. If the lesion has regressed, or shows no progression during treatment, but there was not a complete clinical response, the tumor should continue to be observed and re-evaluated in 3 month intervals[ss1] with DRE lasting and inguinal node palpation for 5 years, anoscopy every 6–12 months for 3 years, and chest/abdomen/pelvic cross-sectional imaging annually for 3 years duration.

L. If there is a complete clinical response, follow-up should be DRE every 3–6 months for 5 years, inguinal node palpation every 3–6 months for 5 years, anoscopy every 6–12 months for 3 years, and reserved only for T3-T4 tumors and/or inguinal node positive patients, annual chest/abdomen/pelvis cross-sectional imaging for 3 years duration.

M. After completion of C-XRT, if the patient progressed during therapy and/or in the months after completion, they should be restaged.

N. If during re-evaluation the patient should show signs of progression, they should be treated in the algorithm for progression and either receive APR (with ipsilateral inguinal lymphadenectomy for clinically positive nodes) if recurrent in the anus, an inguinal lymphadenectomy with external beam radiation (if groins were not in radiation field from the C-XRT) and possibly chemotherapy if recurrent in the groin, or if metastatic, be treated with cisplatin-based chemotherapy or in a clinical trial.

O. Anal melanoma is as aggressive as it is rare, with an estimated incidence of 1.7 cases per one million per year. Approximately 20% of patients will present with node-positive inguinal disease, and an additional 20–40% will present with distant metastasis. There is a median survival of less than 20 months and a 5 year survival of only 20%. Most anal melanoma patients die of distant metastasis.

P. The patient should be assessed for dermal primary lesion to rule out mucosal metastasis. The most common site of melanoma metastasis is lung, followed by bone, liver, and brain so a CT head, chest, abdomen and pelvis should be obtained. As in cutaneous melanoma, PET-CT should be reserved for lesions that are indeterminate on CT.

Q. The surgical management is controversial because of anal melanoma's aggression and rarity, which precludes prospective trials. Retrospective reviews suggest that survival is equivalently poor for wide local excision compared to APR with or without inguinal lymphadenectomy. Incidentally discovered melanoma after hemorrhoidectomy with a negative margin does not require further surgery. Symptomatic patients can be offered local excision for palliation. APR should be considered for symptomatic patients whose locoregional disease cannot be resected by

local excision or for symptomatic local recurrence.

R. Most authors agree that prophylactic inguinal lymphadenectomy in patients with non-palpable lymph nodes is not recommended. Controversy exists regarding lymphadenectomy of palpable or biopsy proven disease, but recent retrospective series suggest that lymphadenectomy does not improve survival.

S. There are no current trials for metastatic anal melanoma, but one can extrapolate from cutaneous melanoma management to conclude immunotherapy or targeted therapy can be used in the setting of metastatic disease. Immunotherapy consists of Anti-PD-1 monotherapy (Pembrolizumab OR Nivolumab), or Nivolumab/ipilimumab. Targeted therapy can be used if a BRAF V600 mutation is present and consists of Dabrafenib/trametinib or Vemurafenib/cobimetinib.

T. Anal adenocarcinoma arises from the columnar epithelium of the anal glands. It is rare accounting for only 1–2% of all gastrointestinal malignancies and tends to present in an advanced stage. Although its rarity precludes prospective trials, retrospective series suggest that anal adenocarcinoma should be managed liked a distal locally advanced rectal adenocarcinoma.

U. Staging requires CT scan of chest, abdomen and pelvis.

V. For locoregional disease, neoadjuvant chemoradiation, followed by APR with adjuvant chemotherapy.

W. For metastatic disease, 5-FU based chemotherapy is warranted.

X. For patients whose poor performance status or comorbidities make them unfit for radical operation, chemoradiation is recommended.

Y. Anal sarcomas mimic the symptomatology of other anal cancers and can be intra- or extraluminal. Anal sarcoma includes differentiation such as leiomyosarcoma, fibrosarcoma and liposarcoma. Sarcomas are radio- resistant.

Z. Treatment for anal sarcoma is APR.

Suggested Reading

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Part III

Pelvic Floor

29 Pelvic Floor Conditions: Rectal Prolapse/Recurrence

Christopher R. Dwyer and Dipen C. Maun

Refer to Algorithm in Fig. 29.1

A. Epidemiology

Rectal prolapse is a pelvic floor disorder typically occurs in elderly, multiparous women, while in men, it typically occurs at a younger age. Although prolapse can affect people of both genders and all ages, it is an uncommon affliction with an incidence reported as low as 0.25% in the adult population and a prevalence of around 1% in adults over age 65. Colorectal surgeons at tertiary referral centers have written the majority of reported data in the literature. Other than these few experiences, little more is known about the epidemiology of the condition.

As little is known about the etiology of primary rectal prolapse, recurrent rectal prolapse continues to be an even greater enigma. The reported incidence after initial operative intervention ranges from 20–30% in some literature and up to half in others. Modern techniques note much lower recurrence rates. Patients with recurrent prolapse may require further laboratory or radiologic examination to help delineate the underlying associated pelvic floor and/or colorectal abnormalities.

B. Physiology

The underlying cause of rectal prolapse remains unclear and is a topic of debate in colorectal literature. Known risk factors for the disease include congenital or acquired and include: multiparity, pudendal nerve disorders, weak pelvic floor and anal canal muscles, weak pelvic floor ligaments, weak internal and external anal sphincters, intrinsic bowel disorders, rectocele, cystocele, or an abnormally deep pouch of Douglas. Other rare causes include neurological illnesses and connective tissue disorders.

The advent of cinedefecography in the 1960s helped colorectal surgeons define the complex physiology of rectal prolapse. Previously postulated as a sliding pelvic floor hernia, full-thickness rectal prolapse has now been defined more as an intussusception. It is important for the colorectal surgeon to identify the correct physiologic process, as operating on the more malicious anorectal intussusception can prove disastrous for the patient and the surgeon Optimizing postoperative continence through preoperative history and physical paired with cinedefecography and manometry is paramount.

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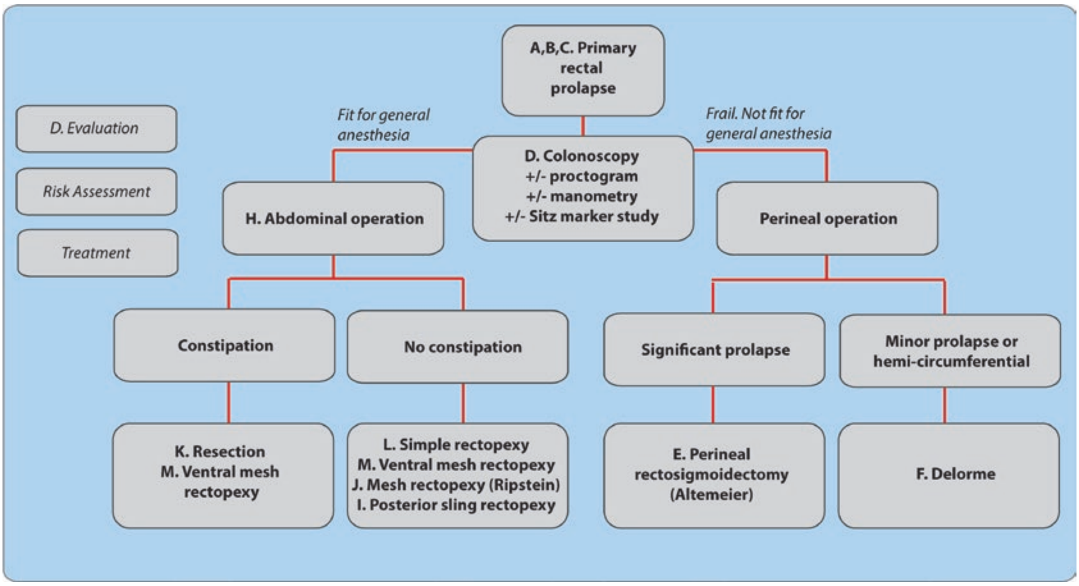

Fig. 29.1 Algorithm for rectal prolapse/recurrence

C. Presentation

Rectal prolapse generally presents in two forms: chronic or acute. The majority of presentations are chronic, with debilitating symptoms such as difficulty maintaining perianal hygiene. Acute rectal prolapse has a more serious presentation that can include ulceration, bleeding, incarceration or gangrene. It is important to evaluate acute presentation on a more expedient basis for the proper operative intervention. In both cases, patients may complain of "something falling out" when they strain or the sensation of "sitting on a ball".

Physical examination offers the opportunity to reduce the prolapse, which displays the classic circumferential full-thickness prolapse with concentric mucosal folds. This is appearance in contrast to the radial folds seen with hemorrhoid mucosal prolapse (Fig. 29.2). Patients will frequently have diminished resting tone and a loose, open anus. Careful digital exam should rule out other concomitant diagnoses such as rectal cancer, cystocele, rectocele, or prolapsed uterus. The surgeon should also note any excoriation of perianal skin, the adequacy of resting tone, and the function of the puborectalis muscle on digital exam. If the prolapse is not apparent during external exam, the surgeon can have the patient sit on a toilet seat and simulate a bowel movement. This maneuver is followed up with an immediate exam in the standing position, or can be observed using a mirror or flexible colonoscope aimed at the anus. Confirmation of full-thickness rectal prolapse with concentric rings of mucosa is key in making the correct diagnosis. In the acute setting (i.e., incarcerated, strangulated), initial determination needs to center around whether or not the bowel is viable or reducible, similar to other hernias. When it is non-reducible and ischemic/gangrenous, this constitutes a surgical emergency.

D. Evaluation

Prior to performing an operation for rectal prolapse, the surgeon must be aware of any concomitant chronic gastrointestinal diagnoses, which may interfere with the repair. Fortunately, there are a few diagnostic adjuncts to utilize in the pre-operative workup of rectal prolapse. A colonoscopy should be performed to exclude any other colon or rectal mucosal abnormalities, especially in

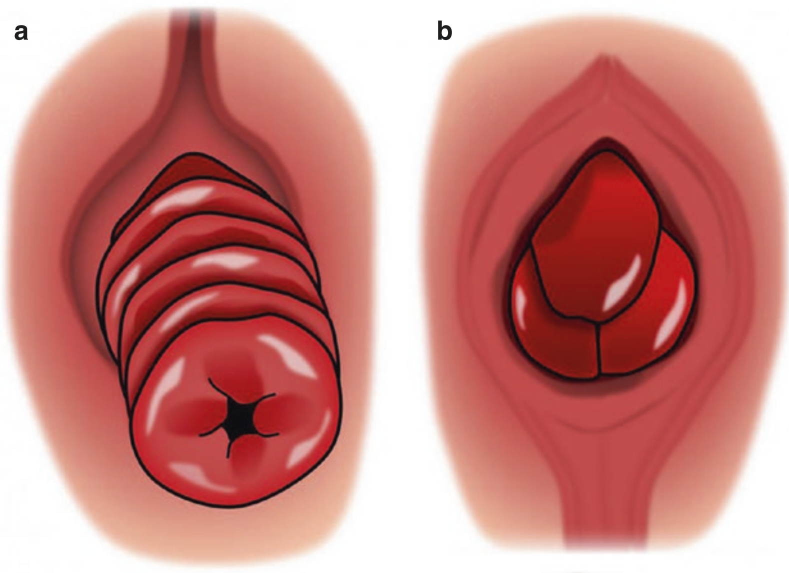

Fig. 29.2 Hemorrhoid mucosal prolapse. (**a**) Circumferential fold consistent with full thickness rectal prolapse. (**b**) Radial folds representing prolapsing hemorrhoids

patients over the age of 50 years. Cinedefecography has been used since its inception in the 1960s, but is unnecessary unless the surgeon suspects pelvic floor muscle dysfunction or internal (rectorectal) intussusception. Anorectal manometry has become more popular with surgeons to record the mean maximal resting pressures in the upper and lower anal canal. It can also help determine sphincter continence, especially in patients with chronic prolapse causing sphincter dysfunction over time. Levatorplasty added to perineal rectosigmoidectomy has been shown to significantly reduce postoperative episodes of incontinence when compared to perineal rectosigmoidectomy alone. Finally, patients with a history of severe constipation should undergo a colonic transit study to evaluate the proximal colon. If slow transit exists, then a concurrent sigmoid resection or subtotal colectomy with ileorectal anastomosis at the time of rectopexy may benefit the patient. Pudendal nerve studies typically don't contribute to the management of a rectal prolapse patient.

E. Treatment-Perineal Rectosigmoidectomy

A Polish surgeon named Jan Mikulicz-Radecki in 1889, only 1 year after he created his famous pyloroplasty technique, performed the first perineal rectosigmoidectomy. Despite the early discovery, this perineal technique was not popularized until the 1970s when Altemeier described the "one stage perineal technique" in his famous *Annals of Surgery* publication.

The procedure is done after full cathartic bowel prep and under either local, spinal, or general anesthesia tailored to each patient's physical status. In the lithotomy or Sims' position, the rectum is prolapsed and injected with epinephrine-containing local anesthetic. A Lone Star® Retractor (CooperSurgical, Trumbull, CT) can efface the rectum and facilitate adequate visualization. One-to-two centimeters below the dentate line a full-thickness incision is made circumferentially around the rectal wall taking care not to injure vessels on the mesenteric side of the rectal wall. These vessels are then divided as the rectum is progressively withdrawn from the body until no further redundancy exists (Fig. 29.3). The abdominal cavity is easiest to enter in the anterior plane as most patients have a deep cul-de-sac. Usage of an energy device during mesenteric ligation can allow for a quicker procedure. In cases of levator diastasis or fecal incontinence, a levatorplasty can be performed prior to the anastomosis (Fig. 29.3). Care must be taken

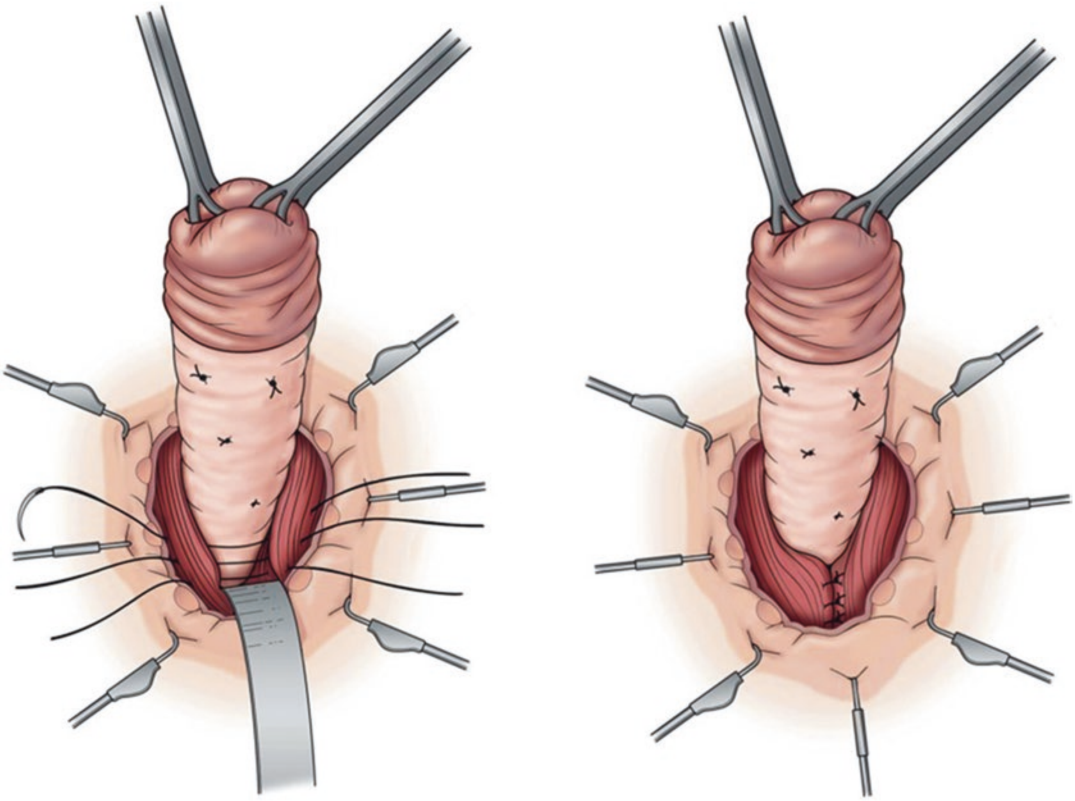

Fig. 29.3 Perineal rectosigmoidectomy with levatorplasty (right). With permission from Williams JG, Madoff R. Perineal rectosigmoidectomy. In: O'Connell R, Madoff R, Solomon M, eds. Operative Surg Colon, Rectum, sixth edn. CRC Press, London, 2015;pp:707–714

not to overly tighten the levatorplasty as this can lead to outlet dysfunction. The authors suggest allowing the easy passage of a single finger between the colon and the anal floor. A colo-anal anastomosis is then performed with interrupted absorbable sutures or with a circular stapling device. The editor's (SDW) preference is to create a colonic j pouch prior to anastomosis.

Numerous studies reporting results with case series exist in the literature since Altemeier's first paper in 1971. Most complications are related to the colo-anal anastomosis and include leak, suture line bleeding, pelvic abscess, and stenosis. The Minnesota group reported on a large series of over 500 procedures in varying age groups and showed an overall recurrence rate of 22.6%. Overall, the mortality tends to be fairly low and most morbidity of the operation is likely related to pre-existing medical problems.

F. Treatment - Mucosal Sleeve Resection (Delorme)

Unlike the Altemeier, the Delorme does not include full-thickness resection. The procedure was originally described in 1900 and includes a mucosal resection with muscular plication. The advantages to the Delorme are the ability to perform the procedure under spinal anesthesia and the lack of a full-thickness anastomosis. It is a good option in patients with minor prolapse, hemi circumferential prolapse and in patients with challenging abdomens.

Similar to the perineal rectosigmoidectomy, the procedure also performed after full mechanical bowel prep and under local, spinal or general anesthesia tailored

to each patient's physical status. The operation begins with delivering the rectal prolapse and injecting epinephrine in the submucosal plane to aid in dissection. A partial-thickness circumferential incision is made through the mucosa and a cylinder of mucosa is separated from the underlying muscularis. The extent of dissection includes the initial incision 2 cm from the dentate line until there is resistance to traction on the intussusceptum. The dissected mucosal cylinder is then removed and the muscularis is plicated longitudinally. The mucosa is then re-approximated with interrupted absorbable sutures.

One of the major drawbacks of mucosal sleeve resection is high recurrence rate. Most reports in the literature range from 0–30%. In two of the larger case series, the recurrence rates were 15% and 27% with reasonable follow up. These case series show the recurrence rate is well above those of the Altemeier procedure. Recorded complications in literature remain similar to the Altemeier and include perioperative myocardial infarction, pneumonia, anastomotic dehiscence, pelvic abscess, and bleeding. A series from Cleveland Clinic Florida has shown significantly better results with the Altemeier procedure with levatorplasty than with the Delorme procedure relative to recurrence rate, length of time until recurrence.

G. Treatment – Anal Encirclement

In 1891, a German surgeon named Thiersch offered an anal encirclement procedure in which a prosthetic was introduced around the anus and cinched down to narrow the opening. This technique has been modified since its inception. The principle feature of the operation is to tighten the widely patulous anus.

The patient is again prepped and commonly undergoes a simple local or locoregional anesthesia. Unlike the Delorme and Altemeier, Theirsch's operation involves reducing the prolapsed rectum prior to the operation. The surgeon then places a loop of 20-gauge silver wire about the outer circumference of the anal sphincter. To facilitate this maneuver, two short incisions in the anterior and posterior positions allow passage of the needle into the perianal space. The loop is then tightened down to the diameter of the proximal interphalangeal joint of the assistant's index finger. Once in place, the surgeon twists the wire to lock its circumference and then points the sharp, cut ends of the wire up and away from the rectum toward the sacrococcygeal ligament. Modifications of this technique in the 1950s utilize silver wire sleeves to avoid the sharp wire ends. More recently, Dacron vascular grafts and prosthetic mesh have been described.

The Thiersch procedure is reserved for complicated patients who are unable to undergo the aforementioned perineal procedures. It does not correct the prolapse and has serious potential morbidity including breakage of the wire, fecal impaction, erosion of the material, or pelvic sepsis. A number of papers have reported recurrence rates from 0–44%. Because of the plethora of problems, the procedure is rarely performed.

H. Treatment – Abdominal Approach Introduction

Since its inception in 1955, the abdominal approach has become the standard of care for full-thickness rectal prolapse in patients who can tolerate general anesthesia. The advent of better anesthetic techniques and minimally invasive surgery like laparoscopy and robotics have allowed us to broaden the indications and offer abdominal approaches to older and sicker patients. While myriad of approaches create an armamentarium for the colorectal surgeon to address rectal prolapse, the main goal of these procedures remains to adequately mobilize the rectum down to the levator plate. The surgical plane may play a role in fixating the rectum to its normal anatomic location. Whether the lateral stalks should be divided was addressed by a Cochrane review meta-analysis. The review determined that division of the ligaments was associated with a decreased recurrence rate but increased rates of constipation.

I. Treatment Posterior Sling Rectopexy
This technique was first described by Wells in 1959 and incorporates the use of a polyvinyl alcohol sponge. This operation begins like all other transabdominal approaches: with mobilization of the rectum posteriorly down to the levator ani. An anterior dissection is performed while preserving the lateral stalks, a maneuver thought to decrease the incidence of postoperative constipation. A piece of mesh, or traditionally a polyvinyl alcohol sponge, is placed into the new rectosacral space and sutured to the presacral fascia in the middle of the mesh. After retracting the rectum cephalad, the lateral borders of the mesh are brought anteriorly creating an incomplete cylinder by fixating the mesh to the anterior rectum. The peritoneal fold is then secured over the foreign body to exclude it from the abdominal cavity.

J. Treatment - Anterior Sling Rectopexy
Initially described by Ripstein in 1952, the posterior rectum is mobilized down to the levator plate; a piece of prosthetic mesh is sutured or tacked to the presacral fascia. The mesh is then wrapped around the rectum effectively creating a sling. The mesh is typically synthetic and serves as a posteriorly fixated, anterior sling. The circumferential wrapping of the rectum by synthetic mesh can lead to outlet obstruction. As a result, a modification of this procedure involves securing the mesh to the lateral edges of the rectum.

Historically, this operation was a constipation-inducing operation, making it not suitable for patients with pre-existing constipation problems. It is also associated with significant morbidity. Aside from constipation and fecal impaction, the major side effects reported are presacral hemorrhage, stricture, small bowel obstruction, impotence, and fistula formation. Additionally, the operation is associated with erosion of the anterior portion of the mesh into the bladder. Because of their problems the Ripstein procedure is not commonly employed.

K. Treatment - Resection Rectopexy
The resection rectopexy was first described in the 1960s by Frykman and Goldberg and still remains the most common treatment option for patients able to tolerate general anesthesia. It is postulated that the resection of the sigmoid colon decreases constipation and possibly lead to lower recurrence. The procedure can be performed in either an open, laparoscopic or robotic method. The surgeon must perform complete mobilization of the rectum to the levator muscles. Second, the rectum is elevated with fixation of the rectum to the presacral fascia, usually around the level of S1. The author favors placing two sutures on only one side of the rectum/mesorectum to prevent rectal kinking and obstruction. Last, the surgeon performs a resection of the redundant sigmoid colon with anastomosis. Complications of this procedure include those associated with colonic anastomosis: infection, bleeding, or anastomotic leak. Perioperative events associated with anesthesia are another possibility. Despite the patient population and the anastomosis, the morbidity and mortality is quite low and recurrence rates range between 0 and 2.5% in most series.

L. Suture Rectopexy
Simple abdominal suture rectopexy without resection has also been described. A complete mobilization of the rectum including the lateral stalks is commonly performed and the rectum/mesorectum is sutured or tacked to the sacrum at the S1 level. This procedure can easily be accomplished using minimally invasive techniques such as laparoscopy or robotics. The robotic approach may potentially facilitate the suturing of the rectum to the sacrum. Rectopexy without resection can lead to worsening of preoperatively recognized constipation and should be avoided in these patients. Simple rectopexy is effective for patients without constipation who can tolerate general anesthetic and allows them to avoid the risk and complications of an anastomosis. Most series show a low recurrence rate between 0–5% with low morbidity and mortality.

M. Treatment - Anterior (Ventral) Rectopexy
The Orr-Loygue (lateral mesh rectopexy) procedure can be considered the first published account of what is now known as the anterior, or ventral rectopexy. This procedure involved anterior and posterior rectal mobilization to the level of the levator ani muscle, removal of the pouch of Douglas, and suturing of mesh to the lateral rectum on both sides. In 2004, Cleveland Clinic Florida alumnus, Professor Andre D'Hoore of Leuven, Belgium modified the Orr-Loygue technique to include posterior dissection only for exposure of the sacral promontory, no pouch of Douglas excision, and placement of a mesh directly to the ventral aspect of the rectum. This technique suspends the middle and lower rectum yet avoids any constipation-producing lateral dissection. Avoiding posterior and lateral dissection also minimizes nerve injury to the autonomic nerves. Biologic or synthetic mesh has been described but additional studies need to be performed comparing complication and recurrence rates between mesh types. This procedure is technically demanding with dissection and suturing in a tight narrow space. Robotic surgery may potentially facilitate and ease the technical burden.

The procedure begins by incising the peritoneum at the sacral promontory and extending it along the lateral sulcus and across the peritoneal reflection. The rectovaginal septum is then dissected all the way down to the anal canal. The placement of an EEA dilator in the vagina can facilitate this part of the dissection. A 20 cm long strip of mesh is then cut in the shape of a spatula; with the distal end approximately 4 cm wide and the handle end approximately 2 cm wide. The wider distal end is then secured to the anterior wall of the rectum with 6–8 interrupted sutures. The proximal thinner portion of the mesh is secured to the sacrum at the level of S1 with either tacks or suture. Figure 29.4 represents the anatomical position of the mesh in the pelvis. The peritoneum is then closed over the mesh. A sacro-colpopexy can easily be done at the same time in cases of anterior compartment weakness/prolapse.

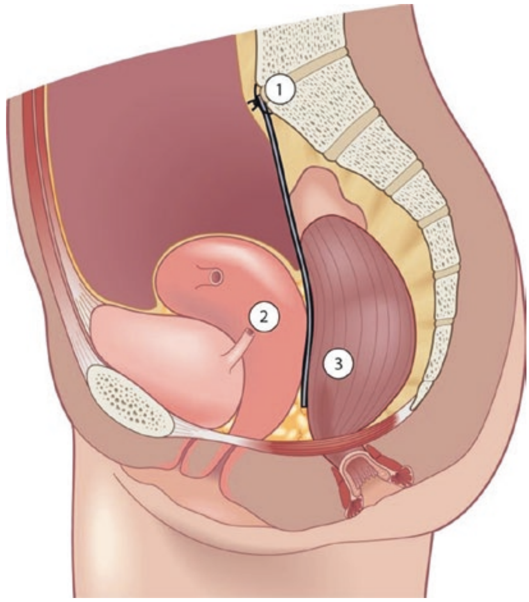

Fig. 29.4 Cross-sectional view of ventral rectopexy with mesh. With permission from D'Hoore A. Laparoscopic ventral rectopexy. In: O'Connell R, Madoff R, Solomon M, eds. Operative Surg Colon, Rectum, sixth edn. CRC Press, London, 2015;pp:729–736

Complications known to this procedure include mesh erosions, rectal stricture, rectovaginal fistula and dyspareunia. Most published series are mainly in the European literature and are quite promising with low recurrence rates and low morbidity. Faucheron reported on 12 non-randomized case series' with a total of 574 patients. The recurrence rate was 4.7% with mean follow-up of 23 months. Constipation was improved in 3–72% of patients, while it was worsened in only 0–20%.

N. Results
Studies comparing the different trans-abdominal approaches to full-thickness rectal prolapse are sparse. Most case series describe one operation and its recurrence rate, morbidity and mortality. These operations all carry fairly low recurrence and morbidity rates while mortality is low. The more interesting aspect of these studies is whether they will remain relevant in an

increasingly laparoscopic and robotic surgery world.

The laparoscopic approach to full-thickness rectal prolapse has been widely accepted by colorectal surgeons. The recurrence, morbidity and mortality rates are similar to open technique, but laparoscopic technique is associated with shorter hospital stays and faster patient recovery and high levels of patient satisfaction. Robotics has become vogue, especially in the pelvis with urology and gynecology and with the advent of the anterior rectopexy. Suturing in the pelvis with the robot is purportedly easier than during laparoscopy. However, whether this claim translates to improved outcomes remains to be seen.

O. Recurrent Rectal Prolapse

The modern day recurrence rate of techniques for full-thickness rectal prolapse is approximately 10%. In general, the recurrence rate is higher with perineal procedures. Therefore, the colorectal surgeon should be familiar with the diagnosis and treatment of recurrent full-thickness rectal prolapse. A thorough knowledge base on the blood supply of the rectum and distal colon must be understood so that the proper operation can be selected.

The usual diagnostic approach to primary full-thickness rectal prolapse should be repeated in a thorough fashion utilizing data from cinedefecography, physical exam, manometry and history. The surgeon should tease out any constipation or other pelvic floor problems that may have been missed prior to the first operation. Full informed consent should include a warning that any existing bowel dysfunction may not improve after attempted repair of the recurrence.

The surgeon should know the patient's prior surgical history and obtain any relevant operative reports. Technique, location of anastomosis, use of mesh, and type of anesthesia are all important to review. Patients who have already undergone a perineal procedure are candidates for repeat perineal procedure or rectopexy (without resection) only. A sigmoid resection in the setting of a previous perineal anastomosis may cause ischemia to the remaining rectal segment. Similarly, a previous transabdominal resection rectopexy limits the patient to repeat transabdominal procedures only. Perineal procedures, with the exception of the Delorme procedure, should be avoided due to similar concerns for an ischemic segment of bowel. If a patient has only undergone transabdominal rectopexy, then both transabdominal and perineal approaches are available options.

Unfortunately, the results of treatment for recurrent rectal prolapse have not been well defined. Most studies are retrospective and lack any significant power to draw conclusions regarding the best treatment modality. A recent review of recurrent prolapse highlighted that postoperative results have been described erratically, with some studies completely omitting constipation, incontinence or sexual dysfunction. Additionally, most studies lacked consistent analysis of preoperative bowel function or pelvic floor dysfunction. Larger paired studies with longer follow-up periods are needed to adequately assess the appropriate treatment for recurrent full-thickness rectal prolapse.

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Check for updates

Pelvic Floor Conditions: Rectal Intussusception

30

Earl V. Thompson IV and Nicole M. Saur

Refer to Algorithm in Fig. 30.1

A. *Internal intussusception*: Patients present in two ways: either with symptoms later determined to be associated with internal intussusception, or after undergoing defecography for an unrelated reason and incidentally found to have what is thought of as an asymptomatic anatomic abnormality. Symptoms vary widely among patients and can range from minor annoyance to physically or socially incapacitating. These can include drainage of mucus or blood, tenesmus, pelvic pressure, chronic constipation, anismus, and fecal incontinence. All of these symptoms could also be associated with other serious anorectal or gastrointestinal conditions and should therefore be carefully investigated. All patients should undergo a complete history and physical examination focusing not only on their specific complaint, but also by evaluating for other possible conditions (Table 30.1). Also, selective use of diagnostic studies can both inform management of internal intussusception and evaluate for other underlying conditions (Table 30.2).

B. *Symptomatic*: Each of the symptoms listed previously may vary in severity, and the clinician will often need to ask the patient specific questions to fully elucidate the functional impact of his or her symptoms. Evaluation of pelvic dysfunction in a female patient should include questions directed at symptoms not only of the posterior (anorectal) compartment but also urogenital compartments. The relationship between fecal incontinence and internal intussusception is somewhat more clearly defined than with other symptoms. It has been shown that fecal incontinence scores worsen as the degree of internal intussusception demonstrated by defecography worsens. In another study, only 17% of patients whose fecal incontinence could not be explained after normal anorectal physiology testing and endoanal ultrasound had normal defecography. The remaining 83% had some degree of internal intussusception. In a study of sacral neuromodulation for fecal incontinence, only 16% of patients with high-grade internal intussusception on defecography completed trial neuromodulation and went on to have symptomatic improvement after device implantation. The physician should also be

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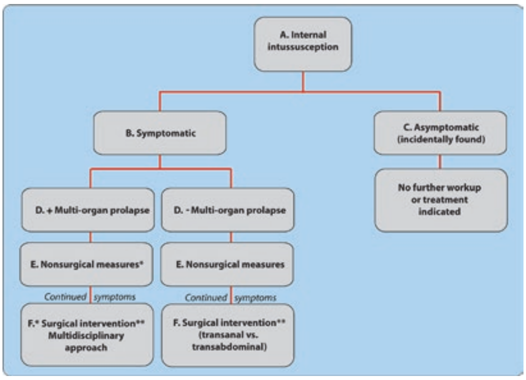

Fig. 30.1 Algorithm for the evaluation and management of internal rectal intussusception ∗Multidisciplinary management ∗∗Surgery only for symptoms directly attributed to internal intussusception or multi-organ prolapse

Table 30.1 Key features of a complete history and physical examination for a patient with internal intussusception

History	Physical examination
History of malignancy	Sphincter tone, scarring, fissures, hemorrhoids
Recent colonoscopy	Full-thickness or mucosal prolapse
Constipation	Vaginal prolapse, rectocele
Fecal or urinary incontinence	Proctoscopy: • Malignancy/polyps • Solitary rectal ulcer • Proctitis
Urinary symptoms	–
Obstetric history	–
Prior anorectal procedures	–

Table 30.2 Diagnostic studies available for evaluation of internal intussusception

Defecography
Barium enema
Colonoscopy
Endorectal ultrasound
Anorectal physiology
Colonic transit studies
Urodynamics

aware that even in patients with proven internal intussusception, the symptoms may not correlate with the severity of the anatomic abnormality alone. For example, it has been shown that there is no correlation between constipation severity scores and the degree of internal intussusception demonstrated on defecography.

SRUS is often discussed along with internal intussusception and rectal prolapse as it is thought to be caused by these conditions or other pelvic floor abnormalities. SRUS is characterized by single or multiple lesions on the anterior surface of the rectum. These lesions can range from typical-appearing cratered ulcers with fibrinous material at the base to polypoid lesions. Diagnosis is confirmed histologically with the finding of fibromuscular obliteration of the lamina propria. As with internal intussusception, SRUS can be associated with blood or mucous discharge, pelvic pain, or difficulty with defecation. The etiology has not been fully described but these lesions are believed to be the result of chronic inflammation, trauma, or ischemia, possibly caused by internal or external rectal prolapse.

No clear consensus exists on management of SRUS. One review offered a treatment algorithm that divided patients into those with SRUS alone, SRUS with full-thickness rectal prolapse, and SRUS with mucosal prolapse or intussusception. Any appropriate prolapse repair procedure is advocated for patients with SRUS and full-thickness rectal prolapse while biofeedback should be first attempted for other patients. If the solitary rectal ulcer does not improve with conservative measures, biopsy should be performed to exclude the possibility of malignancy before further treatment is undertaken. If biofeedback is unsuccessful, patients with SRUS and mucosal prolapse or intussusception can be offered Delorme procedure or rectopexy as discussed later in this section. Patients with isolated symptomatic SRUS unrelieved by biofeedback can be offered local excision or proctectomy with or without coloanal anastomosis. One recent single-institution review of patients with SRUS treated surgically after conservative measure failed to alleviate symptoms provided support for laparoscopic ventral rectopexy in patients with SRUS and full-

thickness prolapse or internal intussusception. Twenty-nine of 30 patients underwent ventral rectopexy, one underwent STARR procedure, and 24 of 30 had satisfactory outcomes at 36 months. The remaining six patients underwent posterior STARR procedure for persistent symptoms with a final rate of ulcer healing of 90% (27/30).

C. <u>*Asymptomatic*</u>: Up to 50% of healthy volunteers undergoing defecography have been shown to have some degree of internal intussusception. Each of the volunteers was screened with an exhaustive survey of bowel habits and none reported any of the symptoms associated with internal intussusception. While it is uncommon for entirely asymptomatic individuals to undergo defecography outside of a study population, this report does illustrate the importance of choosing management options that are designed to improve symptoms and not correct aberrant anatomy that may simply be a variant of normal.

D. <u>*Multi-organ prolapse*</u>: Anorectal (posterior compartment) pelvic floor dysfunction is rarely found in isolation. Female patients will often have associated symptomatic bladder or vaginal vault abnormalities. In one series of patients referred for dynamic cystoproctography for anorectal defects, 71% had cystoceles and 35% had vaginal prolapse greater than 50%. After evaluating 100 patients with pelvic floor dysfunction, these authors were able to conclude that 95% have defects in all three compartments. Patients should be fully evaluated for such conditions as management options will often be impacted by their presence and any patient with multi-organ prolapse should be managed in collaboration with a multidisciplinary team specialized in all facets of pelvic organ prolapse.

E. <u>*Non surgical measures*</u>: Unlike full-thickness rectal prolapse, whose management is typically surgical, the initial treatment of symptomatic internal intussusception should start with non-surgical management in nearly every patient. Treatment options are determined by the specific symptoms and are described in other chapters of this text. As an example, a patient with chronic constipation should be counselled on dietary modification, adequate fluid intake, fiber supplementation, and proper toilet habits. Other patients with symptoms of obstructive defecation may benefit from biofeedback. A retrospective review of dietary modification, biofeedback, and surgery for internal intussusception in 36 patients showed that biofeedback was more likely to improve constipation and incontinence than the other modalities. In a similar retrospective review of 34 patients who underwent EMG-based biofeedback for isolated internal intussusception, there was overall significant improvement in constipation and incomplete evacuation. Thirty-three percent of patients had complete resolution of their symptoms while 48% had no improvement.

F. <u>*Surgical Intervention*</u>: It should be stressed again that surgical interventions should not be undertaken without first exhausting conservative measures. In addition, the specific symptoms and anatomic abnormality being treated should be correlated and treatment goals clear before embarking on any surgical technique. Specifically, patients must be aware that despite correction of the anatomic problem, the functional symptoms will persist and may worsen. As with repair of full-thickness rectal prolapse, surgical repair of symptomatic internal intussusception can be divided in to transanal and transabdominal approaches. There have been reports of successful treatment of obstructed defecation associated with internal intussusception with the Delorme procedure. While this report has not been widely reproduced, it does provide background for the introduction of the stapled transanal rectal resection (STARR) procedure. As described in the first prospective trial of the technique, the STARR procedure uses two firings of a circular stapler to resect redundant rectal wall in a patient with internal intussusception and rectocele. In this first trial of 90 patients

with obstructive defecation symptoms and a combination of internal intussusception and rectocele, there was significant improvement in all measured symptoms after STARR procedure. Later, randomized trials of STARR versus biofeedback for obstructive defecation have shown 81.5% successful treatment with STARR compared to 33.3% with biofeedback. Adverse events in each of these studies have been infrequent with low single-digit percent risks of bleeding or urinary retention as the most serious risks. As is often the case with internal intussusception, correction of the anatomic intussusception does not always correlate with symptom relief. MR defecography before and after STARR shows a high rate of correction of internal intussusception but symptom relief did not correlate with anatomic repair. In spite of these impressive results, the STARR procedure has remained reserved for highly selected patients in specialized centers.

One common criticism of STARR has been the inability of the circular stapler to resect larger amounts of tissue. Modification of the STARR technique to make use of a rechargeable transverse stapler has been offered as a solution to this problem. The authors of the initial description of this technique promote a proprietary transverse contour stapler, the CCS-30 Contour Transtar (Ethicon Endosurgery), as able to resect more tissue and offer the surgeon better visualization of the entire surgical field. These same authors later performed a randomized trial of surgical management of obstructed defecation syndrome in patients with rectocele or rectal intussusception using either the circular or transverse stapler. In 61 patients analyzed after randomization, it was found that both techniques led to significant improvement in symptom scores at 12 months, but that this improvement was only maintained at 24 months in the transverse stapler group. The authors suggest that the contour staplers allow resection of a larger specimen and therefore offer more reliable symptom relief in patients with larger amounts of intussusception.

Another transanal procedure described is transanal repair of rectocele and rectal mucosectomy with one circular stapler (TRREMS). In the initial report of this technique, the redundant, prolapsing full-thickness anterior rectal wall is excised including the muscular layer while the vaginal wall is protected using retraction from a Babcock clamp. A pursestring suture is then placed incorporating the proximal full-thickness rectal wall on the anterior surface along with mucosal and submucosal layers of the posterior surface. Drawing the suture tight around the stapler's center rod and firing the stapler closes the excision wound. The authors stress the importance of protecting the posterior vaginal wall by keeping is separate from the staple line using a Babcock clamp. A trial of this technique applied to 75 patients with obstructed defecation who failed to respond to non-operative measures showed a mean improvement of Wexner constipation score from 16 to 4 at a mean of 21 months follow up. Complications included persistent rectal pain in 3 (4.0%) and strictures in 7 (9.3%) of patients. The authors advocate this technique as a lower-cost management option for anorectocele with mucosal prolapse as it requires only one circular stapler.

Described by the same group as TRREMS, the apex stapling technique for patients with rectal intussusception and mucosal prolapse is conceptually very similar to stapled hemorrhoidopexy techniques such as procedure for prolapse and hemorrhoids (PPH). For the apex technique, a pursestring suture is placed through mucosa and submucosa at the apex, or most distal point, of the prolapse. After the anvil is inserted into the proximal rectum, the suture is secured to the anchor hole in the center rod of an EEA-33 Hemorrhoid and Prolapse Stapler Set (Covidien, New Haven, CT). A second, slightly more distal, pursestring suture is placed and the stapler is fired. In

this first description of 45 patients, mean Wexner constipation scores decreased from 13 to 5 at a median of 120 days follow up. Median operative time was 17 min and mean width of resected rectal wall was 5.9 cm. These authors advocate for this technique as a fast, safe, and low-cost technique to treat rectal intussusception.

As with rectal prolapse, transabdominal procedures are often offered to patients with symptomatic internal intussusception. The clinician should be aware, that while incontinence or constipation may improve with transabdominal procedures, obstructive defecation symptoms are unlikely to improve and may worsen. Ventral mesh rectopexy without bowel resection has been repeatedly shown to be successful in the treatment of fecal incontinence in patients with internal intussusception. Similar results have been demonstrated for constipation. However, it is again important to note that while defecography consistently confirms correction of intussusception, symptomatic improvement does not always correlate with repair of the anatomic derangement after transabdominal procedure for these indications. Multiple trials have failed to show significant improvement of obstructive defecation symptoms with transabdominal posterior mesh rectopexy, and several have shown a decrease in patient satisfaction after the procedure. It is therefore inadvisable to attempt to treat obstructive defecation caused by internal intussusception with posterior rectopexy alone. A recent systematic review of 14 studies including 1300 patients confirms the supposition that posterior rectopexy is obsolete as this technique was not described in any of the trials evaluated. Further, this study noted that improvement in bowel symptoms was noted after ventral mesh rectopexy or resection rectopexy in 73.9% of patients with obstructed defecation and 60.2% of patients with fecal incontinence. These authors found that, while no meaningful conclusions could be drawn due to publication bias and small sample size, ventral mesh rectopexy appeared to have higher recurrence rates but fewer complications, better improvement in bowel symptoms, and shorter operative time compared to resection rectopexy. Therefore, in properly selected patients, ventral mesh rectopexy or resection rectopexy can offer acceptable symptom relief in patients with constipation or fecal incontinence due to internal intussusception.

Despite the various surgical approaches available for the treatment of internal intussusception, surgical intervention should be reserved for selected patients who have failed an adequate trial of conservative management and have symptoms attributable to the internal intussusception. Surgical intervention should not be undertaken simply to correct an anatomical abnormality.

F∗. *Multidisciplinary approach to internal intussusception*: Pelvic floor laxity in the female patient can lead to multi-organ prolapse and a constellation of related symptoms. Addressing only one organ system may exacerbate symptoms in the other systems and therefore these patients should be treated by a multidisciplinary team consisting of colon and rectal surgeons, urogynecologists, pelvic floor physiotherapists, and often, primary care physicians. One large review of abdominal sacrocolpopexy, a procedure widely utilized to treat vaginal vault prolapse, demonstrated that it was successful in eliminating prolapse in 58–100% of patients. However, impact on bowel function was mixed and poorly reported. Some studies showed improvement of pre-existing constipation, some showed 16–26% rates of new constipation, some showed overall subjective improvement in bowel function, and most studies reviewed made no report of bowel function. Techniques that stabilize the perineal body by fixing it to mesh anchored to the sacrum have shown promise in improving bowel function in patients with multi-organ prolapse. One study showed improvement in constipation, splinting, or incontinence in 8 of 11 women who underwent abdominal sacral colpoperineopexy,

although it was limited by its small size and does not describe preoperative rectal defecography findings. The necessity of multidisciplinary management of the patient with multi-organ prolapse is reinforced by the wide variety of procedures described. In addition, the patient's troubling symptom(s) and goals of surgical treatment should be very clearly understood prior to embarking on any surgical option.

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31 Pelvic Outlet Obstruction

Jennifer S. Davids

Refer to Algorithm in Fig. 31.1

A. Although defecation uneventfully occurs in the majority of the population, it is actually a complex physiologic process, under both voluntary and involuntary control. Multiple physiological and psychological disturbances can potentially manifest as defecatory dysfunction, including pelvic outlet obstruction.

Prior to evaluating patients with disordered defecation, it is important to understand the normal physiology of defecation. The defecation process is initiated when the rectum fills with stool and becomes distended. The contents of the low rectum and upper anal canal are "sampled" as the internal anal sphincter relaxes in response to rectal distension by the recto-anal inhibitory reflex, and the external anal sphincter compensates by contracting through the recto-anal excitatory reflex. When the urge to defecate is sensed and acted upon, a seated or squatting position is assumed. The abdominal muscles contract voluntarily to raise intra-abdominal pressure by the Valsalva maneuver. The puborectalis muscle, as part of the levator ani, wraps around the rectum as a "sling;" it relaxes in response to Valsalva, broadening the anorectal angle, allowing for passage of stool (Fig. 31.2). If the urge to defecate is deferred, the external anal sphincter muscles are voluntarily contracted, the puborectalis muscle remains contracted, and the sensation dissipates.

Pelvic outlet obstruction, also referred to as *paradoxical puborectalis contraction*, *obstructive defecation*, *anismus*, or *pelvic floor dyssynergia*, occurs when the puborectalis muscle fails to relax ("nonrelaxation") or contracts further during attempted defecation. Importantly, the puborectalis does not function in isolation; this disorder should be considered a consequence of dysregulation of the pelvic floor musculature with defecation. The rectum will distend with stool, and despite Valsalva, stool is not evacuated.

B. Patients with pelvic outlet obstruction will often present simply as being "constipated." In particular, common symptoms include straining with minimal passage of stools (C), or sensation of incomplete evacuation (D). Stool texture may range from watery/loose (overflow diarrhea) to hard or pellet-shaped. Patients will frequently have the urge to defecate, and will sit on the toilet straining for prolonged periods of time. Failure to defecate often results in abdominal distension and cramping, which can then indirectly result in poor appetite and early satiety. Some patients will perform vaginal or perineal splinting to facilitate passage of stools (E).

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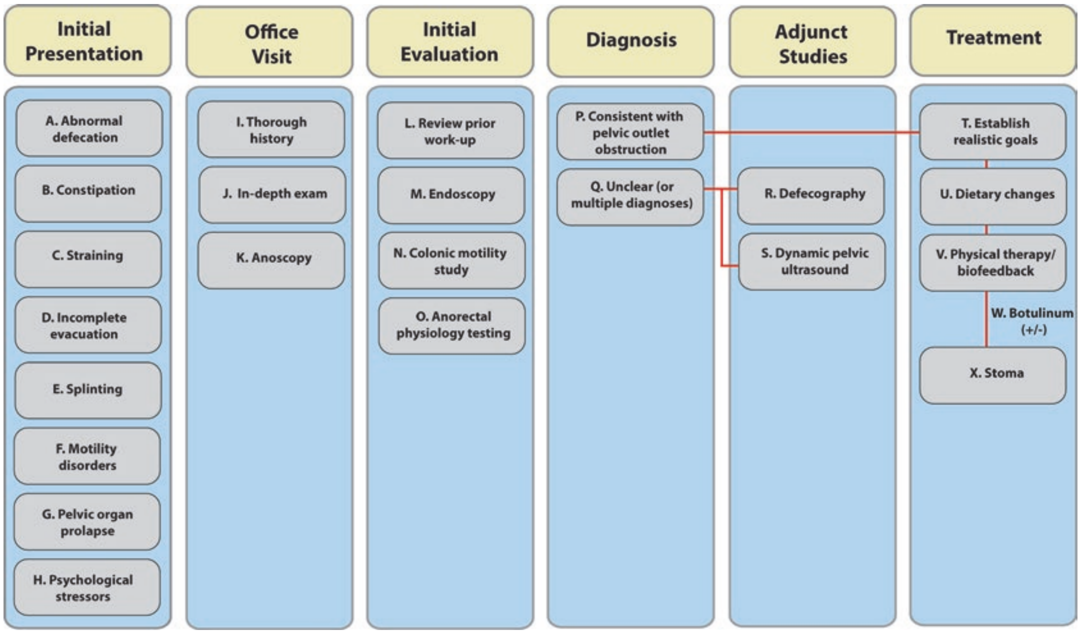

Fig. 31.1 Algorithm for pelvic outlet obstruction

F. Pelvic outlet obstruction frequently occurs in the setting of other associated disorders of gastrointestinal motility or pelvic floor abnormalities, making diagnosis extremely challenging in many cases. Multiple other pathologies may synergistically contribute to "constipation," such as irritable bowel syndrome, slow transit constipation, rectocele, enterocele, rectal prolapse, internal rectal intussusception, and uterovaginal prolapse (G). Half of patients will have abnormal sensation of the anoderm and anal canal. Two thirds of patients with pelvic outlet obstruction also have slow transit constipation.

H. Although some patients with outlet obstruction will report having constipation since childhood, many others will identify "triggers" or inciting events that led to worsening constipation, such as life stressors including new job, divorce, financial trouble, sexual abuse or assault, surgery (often a hysterectomy), or the onset of use of antibiotics or narcotics. Multiple studies have identified a higher incidence of comorbid psychiatric conditions in patients with pelvic outlet obstruction, including obsessive-compulsive disorder, phobia of stool, and eating disorders such as anorexia nervosa and bulimia; some patients have been victims of sexual assault or abuse.

A thorough, detailed history and physical exam are critical to establishing the diagnosis of pelvic outlet obstruction. The differential diagnosis for pelvic outlet obstruction is broad, and includes: Irritable bowel syndrome, slow transit constipation, global dysmotility disorder, short-segment Hirschsprung's, mechanical obstruction including mass, polyp, or stricture, internal rectal intussusception, rectocele, enterocele, or rectal or uterovaginal pelvic organ prolapse; history-taking in these patients is often a lengthy process and should not be rushed. Table 31.1 lists specific elements of the initial history, which should be included.

A detailed past medical and surgical history is equally important. Often these patients have had an exhaustive workup by one more gastroenterologists; all records should be obtained and reviewed. An obstetric history should be taken, noting any vacuum/forceps deliveries, macrosomia, episiotomy or tear, or other complications such as abscess. Patients should be

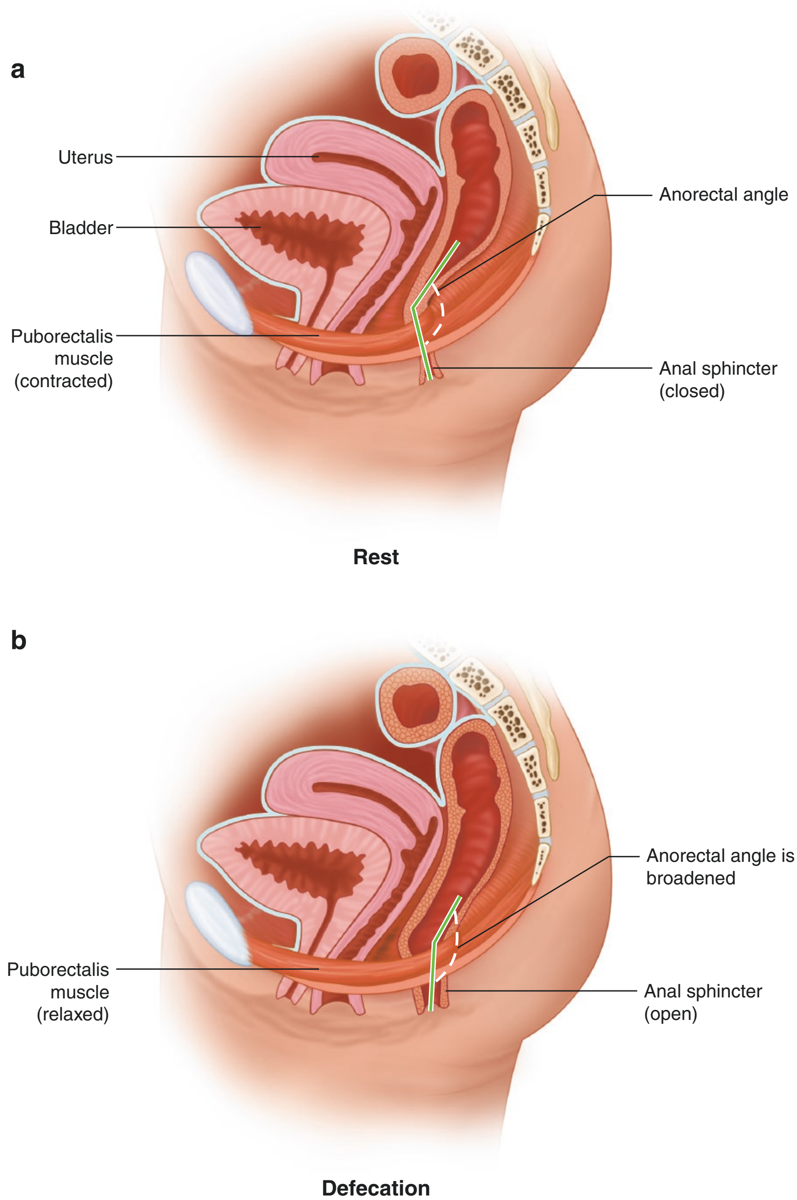

Fig. 31.2 Cross-section of the normal pelvic floor musculature at rest (**a**) and during defecation (**b**). During defecation, the puborectalis muscle relaxes, and the anorectal angle (shown in red) broadens

asked if they have a history of sexual abuse, and also whether any psychiatric conditions are present, including eating disorders, phobias, and obsessive-compulsive disorder.

J. In-office examination by the surgeon is essential, as a skilled examiner is likely to identify obstructive defecation. After an abdominal exam the patient should be placed in the prone jackknife or left lateral decubitus position, an in-depth anorectal exam is performed, beginning with inspection of the anoderm. The perineum should be examined for the presence of scars and bulk to the perineal body. Assessment should note the presence of hemorrhoids, skin tags, fissures, or other lesions and pin-prick sensitivity of the anoderm should be assessed. Digital rectal exam should evaluate resting and squeeze tone, or any masses, as well as the presence and consistency of stool in the vault. Presence or absence

Table 31.1 Important elements of the initial history in a patient with suspected pelvic outlet obstruction

Duration of symptoms, age of onset (childhood, teenage years, or adulthood)
Bowel movement frequency, consistency, timing (erratic or consistent)
Toileting habits: daily routine, sitting, straining, perineal or vaginal splinting
Is there tissue protrusion or a "bulge" with defecation? Is there pain or blood?
Fecal incontinence
Urinary or sexual symptoms
Abdominal pain, cramping, bloating
Emotional or psychological stress, identifiable symptom triggers
Diet: fiber and water intake

of rectocele should be evaluated. Additionally, on digital rectal exam, the patient should be asked to squeeze tightly "as if holding back a bowel movement" and then asked to relax. Next, the patient should be asked to "bear down as if having a bowel movement." Patients with normal pelvic floor mechanics should relax the puborectalis sling and sphincter complex, and there should be appreciable descent of the pelvic floor; the examiner's finger will shift anteriorly. Patients with pelvic outlet obstruction will tighten rather than relax the sphincter complex, and consequently the pelvic floor will contract and not descend. With a clean glove, the vagina may be palpated to assess for evidence of uterovaginal prolapse.

K. Anoscopy should be performed, specifically looking for evidence of bulky internal hemorrhoids, proctitis, or mucosal redundancy. If there is concern for significant hemorrhoidal, mucosal, or full thickness rectal prolapse, the patient should be examined after straining on the commode.

L. Diagnostic evaluation. Prior records should be carefully reviewed to avoid unnecessarily repeating often uncomfortable or invasive studies. With that being said, some diagnostic studies are user-dependent or may change over time, and may therefore need to be repeated. Careful consideration should be given to any diagnostic evaluation to determine what specific question will be answered, and how it could impact management. Accordingly, many so-called "abnormal" findings seen on these diagnostic studies are also seen in asymptomatic individuals, leading to false-positives, further obscuring interpretation.

M. Endoscopic evaluation. Patients should have either flexible sigmoidoscopy or colonoscopy depending on their age, symptoms, and the index of suspicion of co-existing abnormalities of the lower gastrointestinal tract.

N. Evaluation of colonic motility. One method to assess colonic motility is to perform serial abdominal X-rays after the patient swallows a capsule that dissolves in the stomach, releasing radiopaque markers. The X-rays will show the progression of the markers over time. Patients are generally instructed to discontinue all of their laxatives, motility agents, and enemas for the duration of the test; however, the clinician and patient may decide to continue these agents, as the study may otherwise prove to be intolerable with respect to symptoms. X-rays are typically obtained on days 1, 3, and 5. The "classic" finding for patients with pelvic outlet obstruction is that the markers will cluster in the rectosigmoid colon, as they are not being passed through the pelvic floor musculature into the lower rectum (and then evacuated). Patients who also have slow transit constipation may need additional films on day 7, 9, or potentially later to determine if they do eventually cluster in the rectosigmoid colon; transit studies in these patients may be challenging to interpret.

Most commonly used is the Sitzmark capsule (Konsyl Pharmaceuticals, Easton, MD), which contains 24 radio-opaque rings and dissolves when ingested. A simple image obtained 5 days after capsule ingestion will easily diagnose normal transit (Fig. 31.3).

O. Anorectal physiology evaluation. A comprehensive evaluation by a highly skilled and experienced surgeon or technician is essential. Patients should be reassured that the examination should not be painful and will last 30–45 min. Patients need to perform an enema prep 90 min prior to the procedure.

Fig. 31.3 Colonic transit capsule (Konsyl Pharmaceuticals, Easton, MD), which contains 24 radiopaque rings and dissolves when ingested. A simple image obtained 5 days after capsule ingestion will easily diagnose normal transit

(a) Manometry: A probe attached to a pressure transducer is inserted into the rectum, and will enable the examiner to determine rectal pressures at rest, as well as in response to stimuli or to voluntary movement. Using a balloon inflated in the rectum, manometry can be used to assess rectal sensation and compliance, by determining (1) the volume at which the balloon is sensed, (2) the volume that triggers need to have a bowel movement, and (3) the maximum tolerated volume. Additionally it can be used to test RAIR and RAER by monitoring the reflex tracing of the internal and external sphincter when the balloon is rapidly inflated with 10-30 mL of air to simulate rectal distension by stool.

(b) Balloon expulsion: A balloon filled with 50 cc of warm water is inserted into the rectum, to simulate the presence of stool. Patients are instructed to expel the balloon. Most healthy subjects can pass the balloon in under 60 s. Failure to pass the balloon is highly specific for obstructive defecation, and around 50% sensitive.

(c) Electromyography (EMG): A probe is used to quantify the electrical impulse of the pelvic floor muscles and sphincter complex at rest, with voluntary squeeze, and with Valsalva or simulated evacuation. EMG can be used to detect paradoxical excitation of the pelvic floor during Valsalva.

(d) Transanal Ultrasound: 2D or 3D images can be obtained with frequencies ranging from 6 to 16 MHz. Images may demonstrate circumferential thickening of the internal anal sphincter, consistent with a history of chronic straining.

P. If the diagnosis is clear with the aforementioned initial evaluation, it is reasonable to move forward and treat the patient, starting with a conservative approach.

Q. If, by contrast, the diagnosis is still unclear, or if there is evidence of multiple associated abnormalities, it is recommended to pursue further diagnostic evaluation.

R. Defecography is a useful adjunct study to evaluate defecation mechanics in real time. It can be difficult to interpret, as normal, asymptomatic subjects may also manifest abnormalities on defecography. It is an excellent adjunct study if there is concern of concomitant rectocele, enterocele, cystocele, abnormal perineal descent, rectal intussusception, or if the balloon expulsion test was inconclusive. Patients undergoing defecography have barium paste placed into the rectum (approximately 150 mL). Contrast can also be placed in the vagina or instilled in the bladder, and patients may also ingest oral contrast to opacify the small intestine. While sitting on a commode, the patients are asked to evacuate the barium paste from the rectum, as serial images are captured using fluoroscopy. Cinedefecography refers to a series captured using continuous fluoroscopy. Studies of patients with pelvic outlet obstruction will demonstrate

a narrowing of the anorectal angle (or no change) with attempted defecation, with retention of the contrast, corresponding to paradoxical contraction (or nonrelaxation) of the puborectalis sling. Dynamic pelvic magnetic resonance imaging (MRI), also referred to as dynamic MR proctography, can also be performed at some centers where this technology is available. This is performed either in supine or sitting position (with open magnet system) and images are taken while the patient strains, squeezes, and defecates. It does not require intravenous contrast, or contrast to be instilled in the bladder, vagina, or small intestine. The rectum is distended with ultrasound gel. This modality may be particularly helpful to identify soft tissue planes in patients with complex anatomy from prior repairs, and also avoids ionizing radiation.

S. Ultrasound of the pelvic floor is also an effective adjunct to diagnose pelvic outlet obstruction. Both transperineal and endoanal techniques are used to assess the anorectal angle and pelvic floor motion. The study is generally well-tolerated, is inexpensive, and is not associated with ionizing radiation exposure. Dynamic 4D ultrasound technology allows for 3D visualization of the pelvic organs and musculature as a real-time simulation of defecation. With most modern equipment, the operator can record and store multiple cine simulations. Despite its many advantages, dynamic 4D ultrasound is not widely available because it is highly operator-dependent, and therefore it is imperative that the examiner is skilled in this modality.

T. It is important that the clinician clearly expresses honest, realistic goals of treatment and expectations for recovery with the patient. The goals of treatment are to improve defecation mechanics and stool texture, which ultimately, for most patients, will result in a profound improvement in quality of life. Treatment of pelvic outlet obstruction can be extremely challenging and time-consuming. Rarely is pelvic outlet obstruction "cured" with one intervention or in just one setting. Surgical approaches to pelvic outlet obstruction are quite limited; therefore, treatment plans begin with conservative, simple measures aimed at improving stool texture. The best treatment plans employ a multimodal approach (e.g., dietary changes and biofeedback), reserving surgery for failure of the less-invasive approaches.

U. Dietary changes are employed as the first-line therapy to improve stool texture. Patients should increase their dietary fiber intake to 25–30 g per day, and may gradually increase to up to 50 g per day. This goal can be accomplished by adding high-fiber cereal and powdered fiber supplements such as psyllium, methylcellulose, polycarbophil, and wheat dextrin. Fiber wafer formulations or soluble fiber gummies can help bulk up stool. Along with fiber supplementation, patients should stay well-hydrated, particularly in the warmer weather, and consume 1–2 L of fluid over a 24 h period. Patients with severe constipation may also need to add laxatives and other adjunct medications to soften hard stool.

V. Pelvic floor physical therapy can be helpful in improving defecation mechanics in patients with pelvic outlet obstruction. Pelvic floor physical therapy is generally performed by a licensed physical therapist with specialized knowledge of pelvic floor anatomy and biomechanics. Additionally, biofeedback may be performed, which will allow the provider to evaluate the pelvic floor muscle pressure or with electromyography probes, which provides some quantitative data to document improvement and areas for ongoing therapy. Reported efficacy of pelvic floor physical therapy in patients with obstructive defecation is mixed. A meta-analysis of a total of 38 studies demonstrated significant heterogeneity between techniques and approaches, but overall, efficacy ranged from 69% to 75%.

W. Botulinum toxin A (Botox; Allergan; Madison, NJ) has been shown in small studies to improve symptoms of pelvic outlet obstruction. A study of 24 patients, in which botulinum toxin (60 Units) was injected under ultrasound guidance in two sites on either side of the puborectalis muscle using a 23-gauge

needle. Patients did not receive sedation or local anesthetic. Using this technique, the authors demonstrated symptomatic improvement in 19 patients (79%). The symptomatic improvement also correlated with increased anorectal angle on defecography. Given that the effects of the toxin only last 3 months, it is unclear how often (and how many times) the injection would need to be repeated for maintenance of long-term results.

X. Intestinal stoma creation should be considered in select patients who continue to manifest refractory debilitating symptoms. Patients should be counseled that the need for a colostomy should not represent "failure," as it can be a highly effective approach, and may enable them to move past their disease, and experience an improved quality of life. Importantly, patients with evidence of concurrent slow-transit constipation should be considered for ileostomy and not colostomy. It is important to note that some patients may require an intestinal stoma due to their inability to undergo pelvic floor physical therapy due to physical or psychological coexisting conditions; it is therefore not necessary to reserve this option only for those with persistent symptoms despite non-surgical approaches.

In summary, pelvic outlet obstruction is a complex disease that can prove to be a significant diagnostic and therapeutic challenge. The evaluation begins with a detailed history and physical exam. Diagnostic workup is individualized and involves ruling out other associated conditions, such as slow-transit constipation, pelvic organ prolapse, or internal rectal intussusception. Initially, treatment strategies concentrate on lifestyle and dietary changes, and also include pelvic floor physical therapy, botulinum toxin injection, and lastly, surgery.

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32 Pelvic Floor Conditions: Biofeedback

Jennifer S. Beaty and Charles A. Ternent

Refer to Algorithm in Fig. 32.1

Background

The internal anal sphincter is the distal (2.5–4.0 cm) condensation of the circular muscle layer of the rectum. As a smooth muscle in a state of continuous maximal contraction, the internal anal sphincter is a natural barrier to the involuntary loss of stool and gas. The internal anal sphincter contributes 50–85% of the resting tone. The external anal sphincter is the elliptical cylinder of striated muscle that envelops the entire length of the inner tube of smooth muscle which contributes 25% to 30% of the resting tone of the anal canal. The deepest portion of the external anal sphincter is intimately related to the puborectalis muscle. The external anal sphincter is usually inactive at rest. The external anal sphincter will contract with increased intra-abdominal pressure and rectal distension for 30–60 s. The levator ani muscle is the major component of the pelvic floor and is composed of iliococcygeus, pubococcygeus, and puborectalis muscles. The puborectalis is a strong, U-shaped loop of striated muscle that is the most medial portion of the levator ani complex. The puborectalis is responsible for the anorectal sling around the anorectal junction and the anorectal angle, which play roles in both continence and ability to defecate effectively (Table 32.1).

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Pelvic Floor Dysfunction

A. Deranged pelvic floor function encompasses a variety of conditions that often result in significantly decreased health related quality of life. Pelvic floor dysfunction or dyssynergia (PFD) is one such condition. PFD is also known as dyssynergic defecation, anismus and paradoxical anal or puborectalis contraction. PFD is a common entity that can affect up to one half of patients with constipation. The etiology of PFD is not clear, but it appears to represent an acquired abnormal behavior of increased contraction of the pelvic floor and anus with strain effort that interferes with normal defecation. This failure to relax the puborectalis muscle during defecation produces a functional—not a physical—obstruction. Cardinal symptoms of PFD are straining at stools and sensation of incomplete evacuation. The diagnostic criteria for dyssynergic defecation, recently updated in the Rome III report, include those for functional constipation plus at least two out of three investigations (radiology, manometry and

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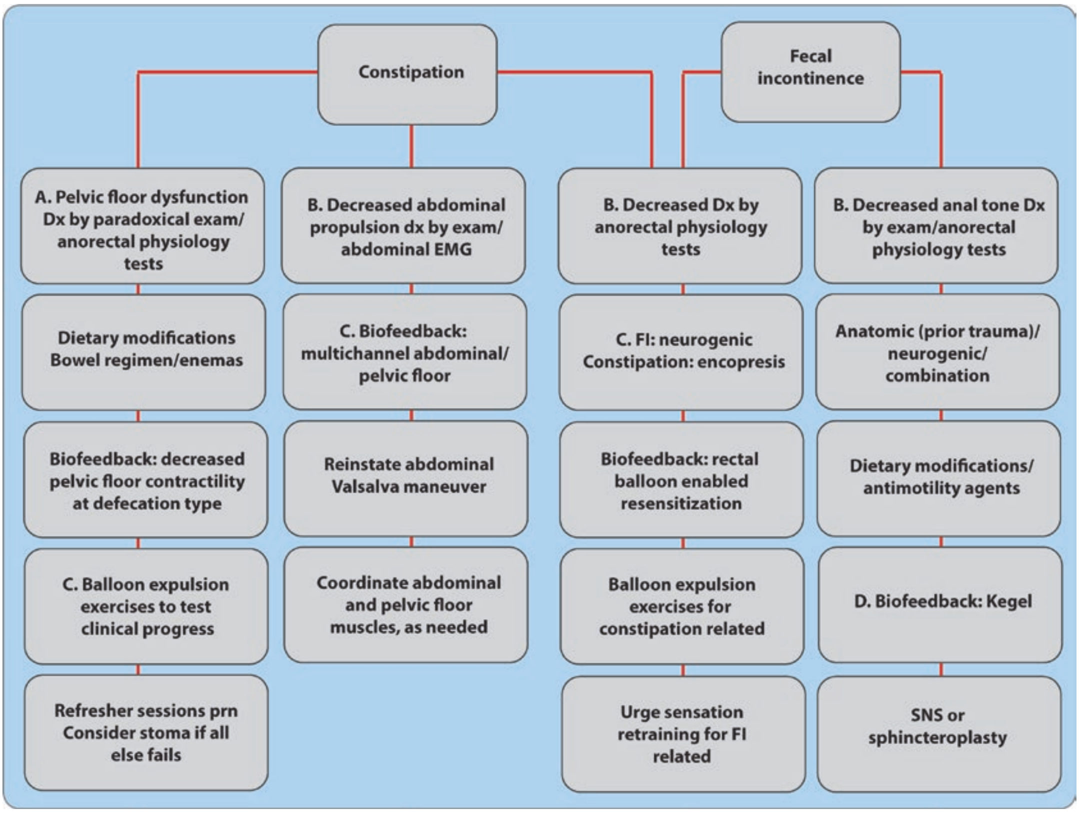

Fig. 32.1 Algorithm for pelvic floor biofeedback; *Dx* diagnosis, *FI* fecal incontinence, *SNS* sacral nerve stimulation

electromyography) showing inappropriate contraction or failure to relax the pelvic floor muscles during attempts to defecate (Fig. 32.2). Inadequate defecatory propulsion represents another abnormal pattern of defecatory physiology described in the Rome III criteria (Romecriteria.org). It is associated with inadequate abdominal propulsive forces and decreased Valsalva maneuver with or without inappropriate contraction or less than 20% relaxation of the anal sphincter during attempted defecation. Fecal incontinence (FI) can also be associated with various derangements of pelvic floor function, including: alteration of innervation of the pelvic floor and anorectal area. In addition, anatomic injury can result in decreased anal canal tone and decreased anorectal sensation which can lead to FI.

B. A history and physical examination can help to diagnose and guide the workup of PFD and FI. A detailed medical history should identify any ongoing issues with infrequent bowel movements, excessive straining with bowel movements and fecal incontinence. A digital rectal exam should be performed to assess appropriate contraction of the anal sphincter and pelvic floor at rest, strain and squeeze. Increased anal canal tone at strain suggests the presence of PFD. Decreased anal canal tone at rest or squeeze may suggest prior anatomic or neurogenic injury in patients with FI. Minimal or absent abdominal Valsalva effort with strain can suggest ongoing inadequate defecatory propulsion issues. Anorectal physiology tests such as anorectal manometry (ARM), electromyography (EMG), defe-

Table 32.1 Biofeedback therapy components available to address specific needs of patients with outlet obstruction constipation and fecal incontinence

	Fecal incontinence	Pelvic floor dysfunction	Decreased rectal sensation	Inadequate defecatory propulsion
Specific pathology	Neurogenic or anatomic anal sphincter compromise	Paradoxical/dyssynergic defecation unlearned behavior	Decreased rectal call to urge from encopresis and chronic rectal stool distention or neurogenic factors	Decreased Valsalva maneuver with effort to defecate unlearned behavior
Regimens and exercise protocols the need to be learned and practiced	Kegel type rest-squeeze cycles of varying time and attempts to maximize squeeze magnitude	Pelvic floor relaxation techniques with defecation/balloon expulsion practice/behavior modification to avoid squeeze during straining to defecate	For encopresis related issues start with a bowel regimen and daily cleansing enemas. Use rectal balloon distention sensory threshold exercises with patient at decreasing volumes from urge and maximum tolerable balloon inflations	Increase abdominal muscle contraction and coordination of breathing patterns and posture and appropriate intra-abdominal pressure generation with strain effort to defecate
Biofeedback visualization/resensitization modality	ARM or EMG	ARM or EMG	ARM based rectal balloon distention	Multi-channel EMG of pelvic floor and abdominal muscles
Therapy goal	Increase anal canal tone at rest and squeeze to help minimize frequency and magnitude of FI symptoms	Decrease paradoxical contraction of the pelvic floor with defecation (strain) to less than 50% of the squeeze activity	Lower rectal volumes that are detected by patients and modify bowel patterns to help reinstate call to defecate with rectal distention	Re-instate appropriate abdominal muscle contraction/Valsalva to generate appropriate intra-abdominal propulsion pressure for defecation while relaxing pelvic floor muscles

cography and balloon expulsion test can provide further evidence for the presence and magnitude of the pelvic floor problem (Fig. 32.2).

Biofeedback Therapy

Biofeedback is a learning strategy that is based on "operant conditioning" and "instrumental learning" techniques. If a behavior—be it a complex human performance such as eating or a simple physiological task such as a muscle contraction—is reinforced by intrinsic or extrinsic means, its likelihood of being repeated increases. Miller proposed that autonomic functions could be regulated by the use of observable and verbal cues. A NATO conference in 1976 called for a broad range of applications for biofeedback. In the present practice of medicine only a few indications can be found for biofeedback therapy and these include the management of fecal incontinence and obstructive pattern constipation. Interestingly, the literature suggests that optimal biofeedback treatment may be through Physical Therapy (PT) specialists as opposed to the use of devices without proper training. Also, instruction by a PT may be more effective than biofeedback alone since both modalities are mutually additive and facilitate attaining the final desired effect. Many insurance companies will pay for pelvic floor PT, but not reimburse for biofeedback whether performed by a physical therapist, medical doctor or other allied health care provider. In order to maximize benefit from biofeedback, the person administering the therapy should have specialized training. PT programs teach a semester of modalities,

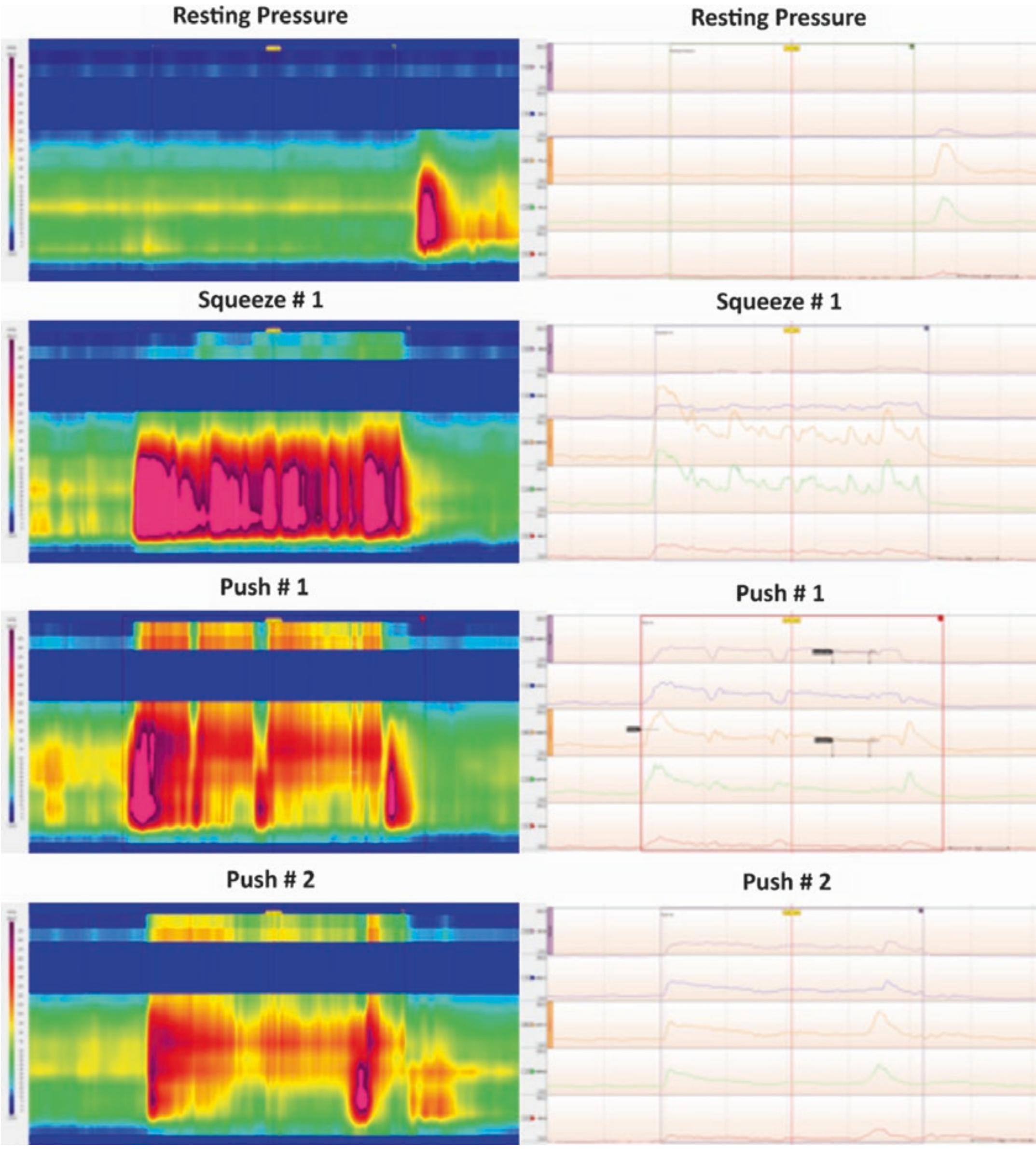

Fig. 32.2 High resolution anorectal manometry showing lack of relaxation of the pelvic floor with strain in a patient with paradoxical puborectalis activity

including 5–10 h on the basic use and interpretation of biofeedback. Specific pelvic floor training can be obtained from the Section on Women's Health of the American Physical Therapy Association which offers a level 1, 3-day course consisting of approximately 4 additional hours of instruction specific to interpreting and instructing biofeedback for pelvic floor disorders (http://www.womenshealthapta.org/2017livecourses/). The Biofeedback Certification International Alliance (BCIA) (http://www.bcia.org) certifies non-physical therapy providers to use biofeedback (RNs, MDs, Massage Therapists, Psychologists, *etc.*). A trained professional should be able to detect subtle yet important substitutions by patients with ancillary muscles (i.e., gluteus muscles) during pelvic floor muscle biofeedback. In addition, a trained professional

should be able to recognize if muscle fatigue is occurring during a treatment session and use this as a signal to stop the biofeedback session prematurely to avoid muscle overuse. There are also differences between the exercises instructed for strengthening (concentric contractions) versus downtraining (eccentric contractions) used for outlet obstructions and pelvic floor pain and tension patterns, respectively. Also, there are different fibers that may be recruited with short quick flicks versus long holds. Optimal pelvic floor biofeedback is therefore, a complicated proposition that entails both directed physical therapy and visualization biofeedback techniques to help improve function. The quality of results with biofeedback depends on the skill of the individual directing the biofeedback and the dedication of the patient to the program.

C. Sensory training was the first biofeedback technique used in clinical practice. It entails simulated defecation by means of a water-filled balloon introduced into the rectum. The balloon is slowly withdrawn while patients are asked to concentrate on the rectal sensation evoked by the balloon and attempt expulsion. Variations of this technique involve defecation of a balloon or simulated stools to improve defecatory dynamics. This technique of rectal resensitization and facilitation of rectal evacuation using biofeedback may be especially useful in patients with decreased rectal sensation, encopresis related outlet dysfunction, PFD and rectal inertia. It can also be used in patients with FI with decreased rectal sensation. We routinely add a bowel regimen with a high/low fiber diet and laxatives/anti-motility agents as needed to promote regular bowel habits. We also employ strategic use of enemas to the sensory biofeedback technique in order to help reinstate the physiologic call to urge that may have been lost. Behavior modification also forms an integral part of treatment for encopresis patients who have lost rectal sensation and the call to defecate as a result of chronic abnormal rectal content retention. The balloon expulsion test with the ability to gradually increase expulsion volumes provides valuable information on the progress with rectal sensation and evacuation.

The 2016 American Society of Colon and Rectal Surgery Practice Parameters for the Clinical Practice Guidelines for the Evaluation and Management of Constipation recommend biofeedback as the main form of therapy for dyssynergic defecation with 1B evidence grading, corresponding to a strong recommendation with moderate quality evidence and benefits that clearly outweigh risks and burdens. A prospective randomized trial investigated the efficacy of biofeedback (manometric-assisted anal relaxation, muscle coordination, and simulated defecation training biofeedback) with either sham feedback therapy or standard therapy (diet, exercise, and laxatives) in 77 subjects (69 women) with chronic constipation and dyssynergic defecation. At baseline and after 3 months of treatment, physiologic changes were assessed by anorectal manometry, balloon expulsion, and colonic transit study, and symptomatic changes and stool characteristics were recorded using a visual analog scale and prospective stool diary. Subjects in the biofeedback group were more likely to correct their dyssynergia, improve defecation indexes, and decrease balloon expulsion time. Colonic transit improved after biofeedback or standard therapy but not after sham therapy. Biofeedback increased the number of complete spontaneous bowel movements and decreased the use of digital maneuvers and was associated with higher global bowel satisfaction. In this study, biofeedback relieved constipation and improved physiologic bowel function in patients with dyssynergia. A high pretreatment constipation symptom score, a high rectal sensory threshold, and a delayed colonic transit time have been associated with poor biofeedback treatment outcomes for PFD.

Hardware requirements for biofeedback training are variable and dependent on patient and provider preference and availability. The positioning of the patient should be that which most comfortably allows optimal visualization of the biofeedback tracings by the patient. One description of EMG biofeedback for PFD involves

patients being seated on a toilet-like chair. Disposable bilateral perianal surface EMG electrodes are connected to the EMG recording device, which provides auditory and visual signals to aid patient observation of muscle activity. Patients are then asked to squeeze, to bear down as in defecation, and to relax the pelvic floor with the goal of lowering the straining EMG activity to a level close to the rest EMG activity. Patients are then trained to expel the rectal balloon connected to a catheter in the lateral position and instructed to practice expulsion of rectal contents while relaxing the pelvic floor during straining at home. Anal canal sponge EMG and surface EMG electrodes can be used to accomplish these goals in patients with PFD. EMG biofeedback tracings can also be used to help patients with FI visualize anal sphincter and pelvic floor activity at rest and squeeze as part of muscle strengthening therapy (Fig. 32.3). Biofeedback training can also be performed with an ARM probe placed in the distal rectum and the anal canal. A balloon is attached to the tip of the pressure transducer catheter, which is used for training rectal evacuation in PFD and to help regain rectal sensation and more complete evacuations (Fig. 32.2). Squeeze and rest anal sphincter exercises based on real-time manometry tracings can also be used to visualize pressure tracings for the specific biofeedback needs of FI patients.

Few studies have compared the different biofeedback protocols for PFD. A 2003 meta-analysis by Heymen et al. evaluating 38 studies

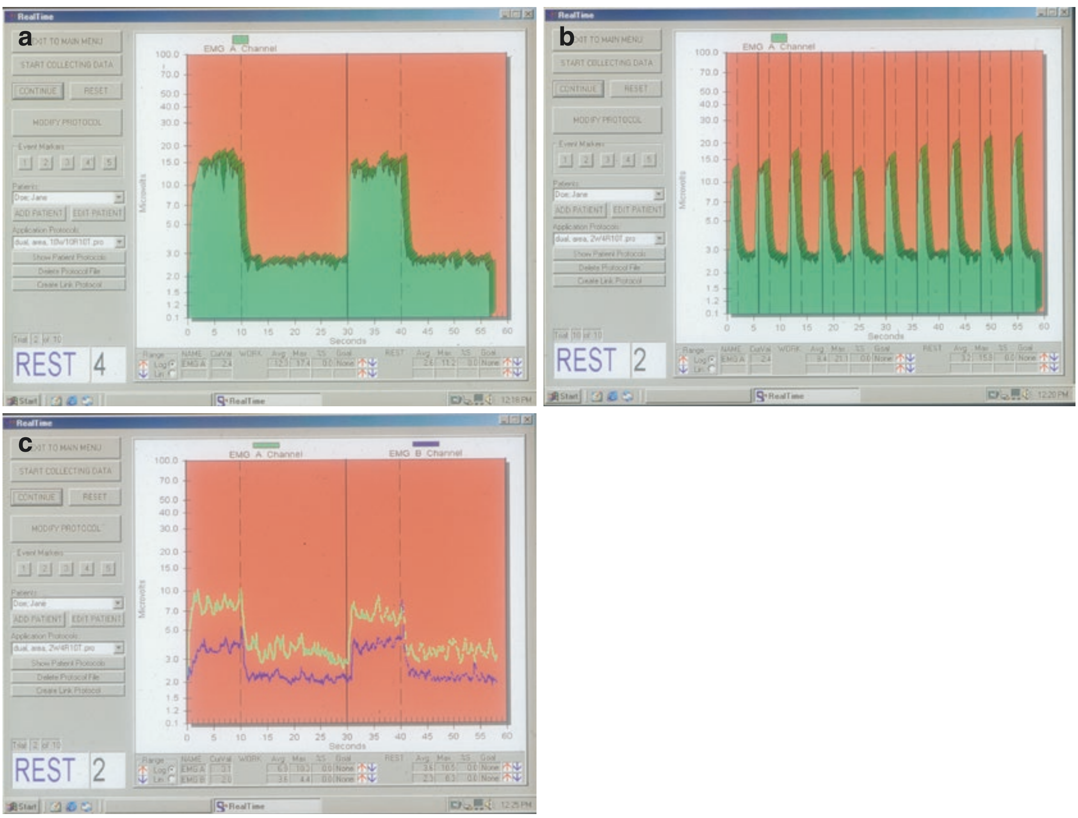

Fig. 32.3 EMG-based biofeedback sequences of a patient with fecal incontinence performing rest and squeeze repetitive exercises documenting magnitude of the squeeze effort compared to rest. (**a**) Represents slow rest-squeeze cycles to work on sustainability of the contraction. (**b**) Fast rest-squeeze cycles to work on endurance. (**c**) Biofeedback session with green tracing representing optimal squeeze goal magnitude for the session and purple tracing representing real-time patient squeeze and rest goal directed exercises

shows a mean success rate of studies using pressure biofeedback (78%) to be statistically superior (P = 0.018) to the mean success rate for studies using electromyography biofeedback (70%) although the clinical significance of this difference remains largely unknown. The mean success rates comparing studies using intra-anal EMG sensors to studies using perianal skin EMG sensors were 69% and 72%, respectively, indicating no advantages for one type of electromyography protocol over the other (P = 0.428).

The cognitive aspects of teaching pelvic floor relaxation at strain for patients with PFD can be challenging. One approach commonly employed and taught by trained physical therapists is the Franklin method. This program may be purchased online from www.franklinmethod.com. This method combines imagery, embodied anatomy and teaching skills to help improve human movement. Essentially, patients are taught to shorten and lengthen in counterbalance form the complementary sets of pelvic floor and spinal/abdominal musculature. Once patients become knowledgeable in the isolation of these muscle groups then the task of correction of the pathologic pelvic floor activity such as dyssynergia is possible. The visual cues of biofeedback are used to reinforce optimal muscle behavior that can then be reproduced outside of the controlled office setting. Another option is to work with PFD patients on behavior modification techniques to isolate the pelvic floor and work on decreased pelvic floor muscle contractility during strain to less than 50% of the squeeze activity and as close to the rest activity as possible. All this should be facilitated by visualizing pelvic floor muscle activity with a biofeedback tracing such as that provided by EMG surface electrodes or anal canal pressure recordings. This latter technique focuses on abdominal muscle and respiration coordination to optimize the Valsalva maneuver while relaxing the pelvic floor during rectal evacuation efforts. Subtle cues by the therapist with the assistance of biofeedback for relaxation of the pelvic floor in PFD can help patients understand appropriate behavior and modify pathologic tendencies. This cognitive realization is crucial and not always easy to overcome and maintain over time. Both approaches to biofeedback therapy for PFD can be effective as stand-alone or complementary programs and represent important elements of the armamentarium to treat PFD.

D. Biofeedback for fecal incontinence may be simpler to teach and involves a combination of Kegel type squeeze exercises under surface EMG feedback of the pelvic floor and rectal resensitization if needed. The 2015 American Society of Colon and Rectal Surgery Clinical Practice Guidelines for the Treatment of Fecal Incontinence recommend biofeedback as an initial treatment for patients with fecal incontinence and some preserved voluntary sphincter contraction with 1B evidence grading, corresponding to strong recommendation with moderate quality evidence and benefits clearly outweighing risks and burdens. The objective benefit reported in the literature has shown substantial variability. Nonrandomized prospective or retrospective case series report 64–89% improvement in incontinence episodes. Randomized trials have compared different approaches of biofeedback, pelvic floor exercise advice and education, as well as telephone treatment, but there are no randomized controlled trials of biofeedback to sham therapy in FI. A recent meta-analysis of 35 studies of biofeedback therapy for FI identified a success rate for studies using Coordination Training (i.e., coordinating pelvic floor muscle contraction with the sensation of rectal filling) of 67%, while the mean success rate for studies using Strength Training (i.e., pelvic floor muscle contraction) was 70%. Furthermore, the mean success rate for those Strength training studies using electromyographic biofeedback was 74%, while the mean success rate for studies using anal canal pressure biofeedback Strength training was 64%. Finally, no patient characteristics were identified that would assist in predicting successful outcome. A Cochrane Database Systematic review from 2012 found that while there is a suggestion that some elements of biofeedback therapy and sphincter exercises may have a therapeutic

effect for FI, this was not certain and larger well-designed trials were recommended.

We routinely perform EMG-based biofeedback for FI although manometry-based can be substituted if needed. Patients are typically placed in the lateral decubitus or supine position with lower extremity support so the pelvic floor activity at squeeze, rest and strain can be easily visualized. Sets of squeeze and rest exercises are initially practiced under therapist supervision in order to maximize the voluntary squeeze over rest effort to the greatest magnitude on the monitor scale. Patients can then practice repeat sets of short pelvic floor and external anal sphincter squeeze and rest exercises while maximizing the magnitude of the squeeze activity. Once this concept is mastered, patients move on to sets of longer squeeze efforts with similarly long recovery times for endurance build-up (Fig. 32.3). These exercises that are learned with the assistance of supervised office biofeedback sessions can then be practiced at home with or without the help of home biofeedback equipment depending on patient and therapist preference and availability.

No specific biofeedback standards exist for the optimal number of sessions, session time length and frequency. One study did evaluate predictors of success for biofeedback in constipation. In 194 constipated patients, biofeedback success rates improved after five or more sessions and was significantly related to patient willingness to complete therapy. In general, patients undergo weekly up to 1-h sessions for 4–6 weeks with assessment of function and clinical progress. The clinical progress with the therapy and patient symptomatology can help to determine whether further extension of therapy sessions and the commonly required refresher biofeedback visits may be of benefit.

Patients are encouraged to practice the biofeedback enabled appropriate pelvic muscle activity and behavior at home to help correct PFD and FI. This can be done with or without biofeedback devices. For patients who prefer biofeedback devices, small units exist that can be placed internally with Bluetooth capability and phone apps that track the progress and intensity of Kegel exercises in real time (http://www.elvie.com). However, the unwanted recruitment of muscles like the gluteus, when performing Kegel exercises, may be detected as appropriate electrical activity on biofeedback devices based on proximity of the regional muscles of the pelvis. This can result in inappropriate feedback and reinforce a suboptimal exercise regimen in some cases. Studies have looked at whether the use of home biofeedback devices offer any advantage over regular exercises following the initial guided biofeedback sessions. No significant difference appears to exist between these two methods. What does seem to be clear is that initial instruction and follow up office visits with biofeedback are important to document continued correct pelvic floor muscle activity and fine tune any deviations in the recommended exercises. Patients often benefit from refresher sessions using biofeedback techniques along with physical therapy methods to maintain the progress and correct any recurrent pathologic behavior of the pelvic floor.

Contraindications to biofeedback do exist, including an allergy to electrode or contact material and patients who are unable to understand or respond to the instructions of the therapist. If a patient has a diminished skin or rectal sensation, the full benefit of therapy may not be achieved. In addition, certain geographic regions may not have readily available certified biofeedback therapists within a reasonable travel distance. The availability of specialized pelvic floor physical therapy specialists can be further searched at http://www.womenshealthapta.org/pt-locator/.

Suggested Reading

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Pelvic Floor Conditions: Fecal Incontinence

33

Mary T. M. O'Donnell and Joshua I. S. Bleier

Refer to Algorithm in Fig. 33.1

A. History and Physical: Etiology, Severity, and Comorbidities

Initial Evaluation:

- Focused History
- Dietary and Bowel History
- Medications History
- Obstetric History
- Examination Including Anoscopy and DRE
- Incontinence Scoring

Fecal incontinence can have a wide differential and a thorough history and physical exam with digital rectal exam and anoscopy are necessary. Often, simple dietary or medication changes can affect dramatic improvements in continence without the need for any surgical intervention. Within a comfortable clinical environment, the surgeon should determine the onset and frequency of symptoms as well as the change in bowel consistency. Onset of symptoms may coordinate with new exposures or behavioral changes leading to an etiology. Changes in bowel consistency temporally related to a patient's symptoms may similarly point to a cause. Lastly, frequency of symptoms with regard to the type of bowel movements helps determine the severity of the FI and can be used with a number of scoring scales including Fecal Incontinence Severity Index (FISI), Fecal Incontinence Quality of Life scale (FI-QOL), and the Vaizey/St. Marks Incontinence Score. The most commonly used scoring scale is the Wexner/Cleveland Clinic Florida Fecal Incontinence Score (CCF-FIS) (Table 33.1).

Frequently, conservative alteration of the stool consistency and its transit time is all that is required to dramatically improve the symptoms of this condition. If these methods are unsuccessful, augmentation of the pelvic floor function or reconstruction of the injured structures may improve continence. Lastly, if all of these fail, stoma formation can improve quality of life in patients with what is an often embarrassing and life-limiting condition. Knowing a patient's baseline disease severity can be used to guide treatment by determining its efficacy.

Fecal incontinence can be caused by medications, direct sphincter injury, anorectal diseases, anal or rectal cancers, the *treatments* of anal or rectal cancers, neurologic disorders, radiation-induced injury, IBS, overflow from chronic

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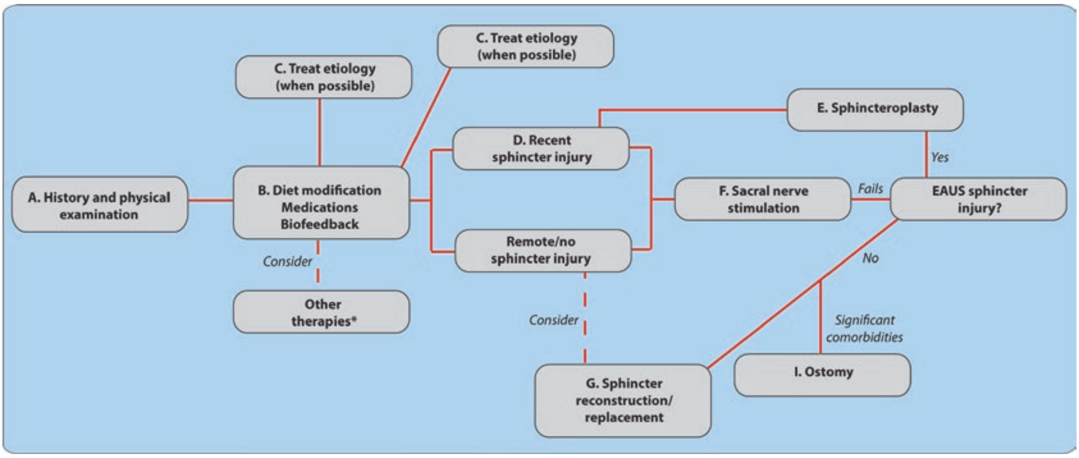

Fig. 33.1 Algorithm for evaluation and treatment for fecal incontinence

Table 33.1 Cleveland Clinic Florida Fecal Incontinence Score (CCF-FIS)

Type of incontinence	Frequency				
Solid	0	1	2	3	4
Liquid	0	1	2	3	4
Gas	0	1	2	3	4
Wear pad	0	1	2	3	4
Lifestyle altered	0	1	2	3	4

In order to determine a patient's baseline and the efficacy of treatments of FI, severity must be graded and there are a number of scoring scales available: Wexner/Cleveland Clinic Florida FI Scale (CCF-FIS), the Vaizey/St. Mark's Incontinence Score, Fecal Incontinence Severity Index, and the Fecal Incontinence Quality of Life scale. Below is the CCF-FIS, which is most commonly used

0 = never; Rarely: <1/month; Sometimes: <1/week or 1/month; Usually: 1/day or 1/month; Always: 1/day or more

constipation, and diabetes-induced neuropathy. The most common cause of fecal incontinence in women is injury to the anal sphincter complex and/or the pudendal nerves, usually during childbirth. Obstetrical injury of the sphincter, which can accompany up to 30% of vaginal deliveries, may only manifest in women later in life, years after injury, as the pelvic floor weakens and other aspects of the coordinated function of continence begin to weaken. Pudendal nerve damage has been demonstrated in up to 60% of patients with obstetrical tears. A complete and detailed obstetrical history is important to obtain in the >40 year old female patient presenting with FI.

Congenital malformations that have led to disordered proprioceptive response of the rectum, radiation therapy sequelae and even low rectal surgery are examples of etiologies of fecal incontinence in patients with intact sphincter complexes. Patients who have undergone low rectal surgery often have issues with FI after complete healing of the pelvic anastomosis. Trauma from sexual abuse, impalement, or foreign body insertion can lead to larger portions of the sphincter complex and a delicate approach should be used to elicit that information. The history and physical exam should be directed towards determining the presence of any of the above etiologies, to include history of hemorrhoids, rectal prolapse, Crohn's disease, neoplasm, degenerative neurologic disorders, and/or chronic diarrhea/constipation, all of which could cause FI.

Finally, the presence of severe comorbidities may limit the incontinent patient's options for surgical repair. Up to 50% of institutionalized patients have fecal incontinence and the presence of severe comorbidities may limit the extent of surgical treatment.

B. Optimization of Diet and Medical Management

Once the etiology of FI has been determined to be benign and not secondary to another underlying

anorectal disorder, initial treatment should always be conservative. A trial of a combination of the methods below should be attempted prior to any surgical management strategies.

Key Components of Conservative Management

- Dietary Modifications
- Fiber Supplementation
- Medical Management Including Anti-diarrheals
- Consideration of Biofeedback

Dietary Modifications

Dietary modifications may aid in the treatment of FI, but require the patient to keep a careful log of food or supplements that triggers their symptoms. Attention should be directed towards caffeine, medications, low-fiber intake, sugar replacements, lactose, and even short-chain carbohydrates (FODMAPs) in an effort to determine any relation towards diarrhea and urgency. Counseling from a specialist regarding diet habits, fluid intake, bowel routines, and medications has been shown to improve FI severity in 22–54% of patients.

Fiber Supplementation

Because fecal incontinence is a result not only of anorectal physiology, but also the stool consistency and colonic transit time, fiber supplementation and anti-motility agents have also shown improvement in symptoms, by providing volume and bulk and consistency to stool. Men and women should add a supplement to reach a goal of 35 g and 25 g fiber per day, respectively.

Medications

If the patient with FI still has loose stools after fiber supplementation, attention should be paid to any medications which may be causing loose stool. Once these have been ruled out, antidiarrheal medications like loperamide, amitriptyline, and diphenoxylate-atropine may help improve stool consistency and therefore FI. Loperamide has been shown to increase anal resting pressure, improve rectal sensation, and retention of fluid load through its inhibition of peristalsis via the enteric Mu receptors. Amitriptyline can reduce frequency and amplitudes of rectal motor complexes through its anticholinergic properties.

Biofeedback

Biofeedback, or pelvic floor rehabilitation, is a non-invasive technique used to improve sensation, coordination, strength, and function through training of the pelvic floor. While some case series have shown improvement in incontinence episodes with pelvic floor exercise and expert advice, randomized controlled trials have shown no advantage to sham therapy. Despite definitive evidence of symptom improvement, the low morbidity of a trial of biofeedback obviates the value of a trial of therapy prior to surgical interventions.

C. Treat Anatomic Etiology (When Possible)

Other diseases or conditions can have fecal incontinence as a symptom of their presentation. These etiologies need to be ruled out and treated prior to pursuing a pathway for treatment of refractory FI. The majority of these sources of pseudo-incontinence can be ruled out with a thorough history and physical exam including clinical anoscopy. Defecography can be of some value if rectal intussusception is suspected.

(a) Rectal Prolapse
(b) Hemorrhoids
(c) STDs
(d) Anorectal Neoplasm
(e) Fistula-in-ano

Incontinence due to rectal prolapse, anorectal neoplasm, or fistula-in-ano may effectively respond to surgical intervention for the primary presenting problem, while STDs and hemorrhoids require antibiotics or fiber supplementation. Depending on the etiology of pseudo-incontinence, it must be treated. Once these sources are treated, it may be discovered that the patient truly has a component of physiologic FI amenable to one of the therapies discussed below.

D. Suspected Recent Sphincter Injury

Women who present with new onset FI within 1 year of vaginal delivery should be suspected to have sphincter complex injury. Physical exam findings suggestive of sphincter disruption include perianal scars or a thinning perineum. The normal anal canal should appear well approximated (not patulous) with intact perianal sensation and anocutaneous "wink" reflex. They should undergo anoscopy and endoanal ultrasound evaluation of the sphincter complex. Endosonography can help diagnose an occult anal sphincter injury, atrophy of the sphincters, and the presence of scar tissue. The presence of a sphincter defect may be an indication to perform either an end-to-end or overlapping sphincteroplasty. Sphincteroplasty outcomes in improving FI demonstrate the most promise when performed in women with recent obstetrical injuries. Unlike outcomes with sphincteroplasty with older injuries (>5 years), the functional improvement may last in the long-term.

It should be noted that after the initial injury has healed, if FI persists, sacral nerve stimulation (SNS) may still be considered as a first line therapy. No documentation of sphincter injury is necessary in this case and furthermore, if necessary, SNS may even be used as a bridge to sphincteroplasty if necessary. Because a large percentage of FI due to obstetrical sphincter injury is remote from the time of injury, and only presents once compensatory mechanisms are weakened or are due to pudendal nerve injury, it may be less invasive and optimal to start with SNS treatment in these patients, especially since a prolonged delay in sphincter repair has poor durability.

If the injury is more devastating or alternatively located, a well-trained Colorectal surgeon can consider reconstruction of the sphincter complex via the approaches discussed below. In the absence of sphincter disruption, a reconstructive or replacement option should be *considered* in healthy patients. Depending on patient preferences or the patient's co-morbidities, ostomy formation can also be considered if complex perineal surgery is an undesirable option.

F. Sphincteroplasty

Studies have demonstrated short-term improvement in continence in up to 76% of patients with post-obstetrical sphincteroplasty. At about 5 years after repair, continence decreases significantly to anywhere from 18% to 50%, but patient satisfaction rate remains at 45–80%. If the is sphincter damage is temporally associated with FI, overlapping sphincteroplasty may be the optimal choice for a *delayed* repair. If documentation of the sphincter injury is needed, endoanal ultrasound (EAUS) can be helpful. This is often necessary to confirm anatomy if sphincter repair is planned. If sacral nerve stimulation has begun to fail the patient as a therapeutic intervention, reexamination of the sphincters through ultrasound should be considered.

End-to-End Sphincteroplasty

Early after obstetrical sphincter injury, a primary end-to-end sphincteroplasty is an option, serving to reapproximate the two ends of a damaged sphincter complex. This is only feasible since significant scar has not yet formed in the area of injury. If there is an open wound with the sphincter complex already exposed, this should be used, but is usually employed by the Obstetrical Gynecologist in a post-delivery repair. The authors recommend delaying definitive repair for at least 3 months, until acute inflammation, local sepsis and soft tissue injuries have healed. If FI is still a problem, a sphincter repair should be considered.

Overlapping Sphincteroplasty: Figs. 33.2, 33.3, and 33.4

If injury is remote or if primary repair fails, a delayed repair can be performed once inflammation has decreased. A curvilinear incision is made anteriorly along the outer edge of the sphincter up to 180° of the circumference. The incision should not exceed 180° in order to avoid injury to the laterally-located pudendal nerves. The incision is deepened to expose healthy sphincter muscle, which is then mobilized from surrounding fatty tissue and reapproximated in an overlapping fashion anteriorly. The internal and external sphinc-

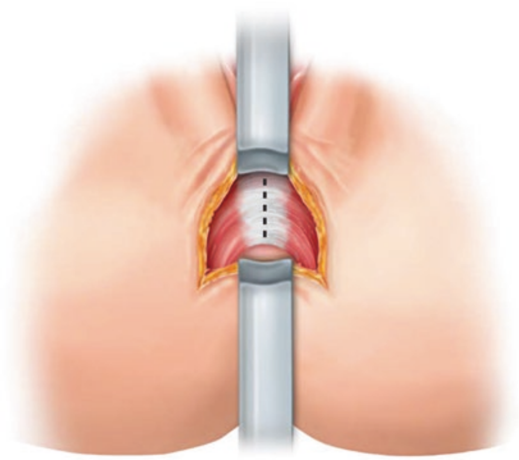

Fig. 33.2 Sphincteroplasty. The sphincter muscle is mobilized from the surrounding fatty tissue and the severed ends are reapproximated en bloc with both the internal and external sphincter with permanent or slow absorbing suture. Care must be taken not to extend the incision past 180° to avoid injury to the pudendal nerves. In the more common setting of delayed repair, there is frequently a significant amount of scar briding the distracted ends of the sphincter. This is maintained in situ. (With permission from Gurland B, Hull T. Overlapping repair. In: Wexner SD, Fleshman D (eds). Master Techniques in Surgery. Colon and Rectal Surgery. Anorectal Operations. Wolters Kluwer, Philadelphia, 2012)

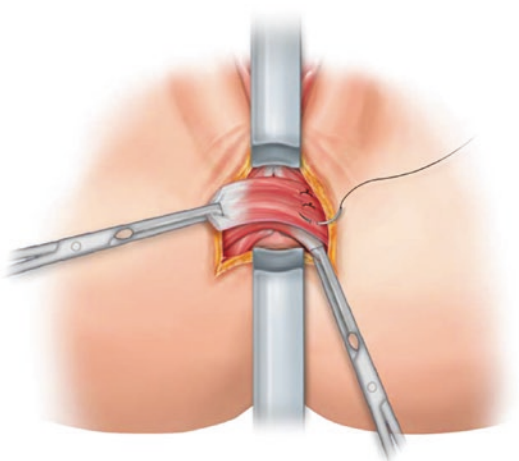

Fig. 33.3 Sphincteroplasty. Severed ends of the sphincter muscle are overlapped and sutured with long term absorbable suture. (With permission from Gurland B, Hull T. Overlapping repair. In: Wexner SD, Fleshman D (eds). Master Techniques in Surgery. Colon and Rectal Surgery. Anorectal Operations. Wolters Kluwer, Philadelphia, 2012)

Fig. 33.4 Sphincteroplasty. This repair tends to lengthen the perineal body and the perineal incision comes together in a Y-shaped formation so that the midportion of this incision is left open for drainage. (With permission from Gurland B, Hull T. Overlapping repair. In: Wexner SD, Fleshman D (eds). Master Techniques in Surgery. Colon and Rectal Surgery. Anorectal Operations. Wolters Kluwer, Philadelphia, 2012)

ters are mobilized as one unit and overlapped, leaving the midline scar in place. The ends of sphincter that are overlapped are then sutured in place with 3–4 slow-absorbing figure-of-eight or horizontal mattress sutures. The perineal body is lengthened as a result and the incision reapproximates as a Y-shaped incision, the center of which is usually left open for drainage. Individual isolation and repair of internal and external sphincters separately is technically more difficult, but also has good evidence of efficacy. A seldom-used repair is the Parks' postanal repair.

G. Sacral Nerve Stimulation (SNS)—See Figs. 33.5 and 33.6

The most promising modality for the treatment of FI is sacral nerve stimulation (SNS). The procedure is not only less morbid than other surgical options for FI, but the salutary effects on continence are immediate. Again, in patients with obstetrical injuries, whether healed with persistent FI, or presenting later in life once compensatory mechanisms have diminished, SNS can

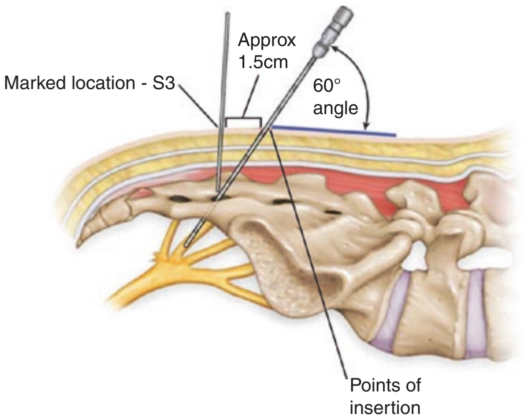

Fig. 33.5 Sacral nerve stimulation. Placement of a quadripolar lead electrode adjacent to the S3 nerve root via a trans-sacral foraminal approach. (With permission from Matzel KE. Sacral nerve stimulation. In: Wexner SD, Fleshman D (eds). Master Techniques in Surgery. Colon and Rectal Surgery. Anorectal Operations. Wolters Kluwer, Philadelphia, 2012)

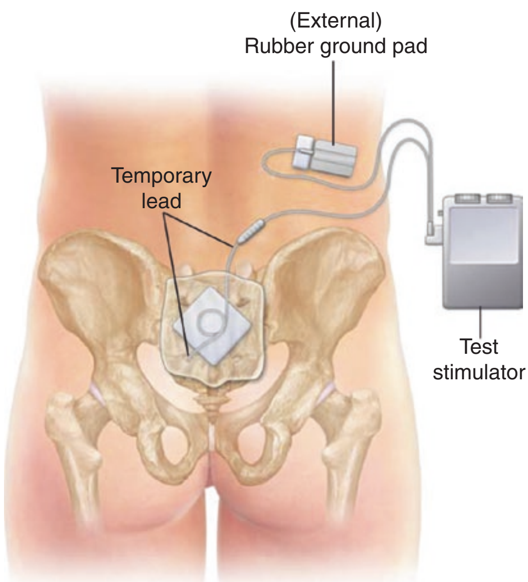

Fig. 33.6 Sacral nerve stimulation. The initial test phase can be performed in the office using a temporary, unipolar non-tined lead, which is placed using either anatomic landmarks or fluoroscopic guidance. (With permission from Matzel KE. Sacral nerve stimulation. In: Wexner SD, Fleshman D (eds). Master Techniques in Surgery. Colon and Rectal Surgery. Anorectal Operations. Wolters Kluwer, Philadelphia, 2012)

provide excellent results. Patients with refractory FI of any etiology should be considered for SNS therapy as well, such as low anterior resection syndrome or complications from lateral internal sphincterotomy or other anorectal surgery.

SNS is a staged procedure involving placement of a quadripolar lead electrode adjacent to the S3 nerve root via the sacral foramina. The initial stage involves testing for symptomatic improvement in FI which can be done via two methods. In the outpatient office, a temporary, non-tined, unipolar lead can be placed using anatomic landmarks with a 3–7 day trial of symptom improvement. The second method involves operative placement of the permanent quadripolar tine lead under fluoroscopic-guidance and a trial of approximately 2 weeks is performed with an external battery. The battery is programmed with the settings that produce the best motor responses intraoperatively. The patient must record the number of fecal incontinent episodes: if >50% reduction is achieved, then a permanent device can be inserted using those settings. In patients with FI of any etiology, including sphincter defects up to 120°, there is up to a 90% reported success with 48% of patients achieving perfect continence.

Prior to trial of SNS, the physician must ensure not only that more conservative management has failed, but that the patient's incontinence is frequent enough that the trial period of 1–2 weeks will be long enough to demonstrate a difference with therapy.

Tibial Nerve Stimulation

Another technique that should be mentioned is posterior tibial nerve stimulation (PTNS). It is non-invasive and therefore has very low morbidity, which is why it should be considered in the therapy for FI. Through transcutaneous or percutaneous electrodes, the posterior tibial nerve is stimulated at a superficial area in the foot. Therapy is performed over 3 months, with twice daily 20 min sessions. Randomized controlled trials have been performed which have shown improved incontinence scores after treatment, though the results are not as profound as with SNS. Unfortunately, at the time of publication, PTNS is not available for this indication in the USA.

H. Sphincter Replacement

If an overt sphincter injury is found, whether from traumatic accident, foreign body or other etiology, attempts at more conservative measures, such as SNS should be employed first. If these measures fail, surgical reconstruction of the sphincter may be required. The prognosis in such cases with sphincter repair alone are poor, but the function and physical nature of the cerclage that the sphincter complex creates is a necessary part recreating continence in this group of patients. As indicated above, early post-obstetric injury represents one of the few etiologies that may result in good long-term function with sphincter repair alone.

Sphincter Replacement Options

- Graciloplasty ± *Dynamic Neuromodulation* (not available in the USA at the time of publication)
- Gluteoplasty
- Artificial Bowel Sphincter (not available in the USA at the time of publication)
- Magnetic Anal Sphincter (not available in the USA at the time of publication)

Graciloplasty

In the patient with an unreconstructable sphincter disruption, sphincteroplasty may be impossible. In such cases, dynamic or stimulated graciloplasty has shown significant improvement in quality of life and incontinence symptoms. The gracilis muscle is harvested, tunneled around the sphincter, and sutured in place. In the unstimulated approach, patients learn to voluntarily contract this muscle to improve continence. In the *dynamic* version of graciloplasty, neuromodulation stimulates the fast-twitch skeletal muscle of the gracilis neo-sphincter to convert to slow twitch muscle fibers improving functional outcome of the reconstruction. Unfortunately, there are very few centers with expertise in this technique, and referral to centers of excellence is required (Figs. 33.7 and 33.8).

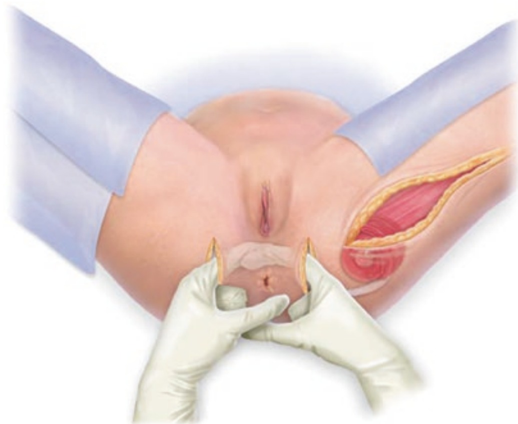

Fig. 33.7 Graciloplasty: This technique involves harvesting and transposing the gracilis muscle as a proximally pedicled flap. The muscle is tunneled around the sphincter complex and sutured in place. (With permission from Baeten C, Breukink S. Dynamic graciloplasty. In: Wexner SD, Fleshman D (eds). Master Techniques in Surgery. Colon and Rectal Surgery. Anorectal Operations. Wolters Kluwer, Philadelphia, 2012)

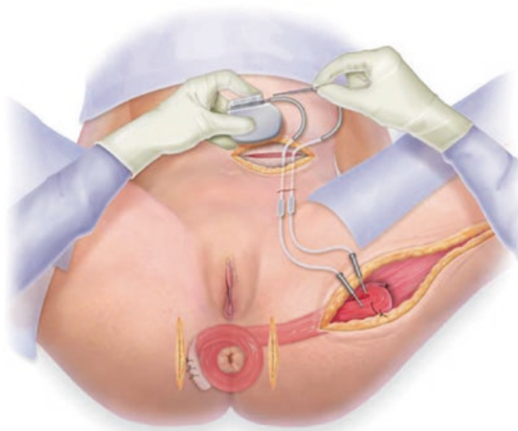

Fig. 33.8 Graciloplasty. In the superior stimulated version, neuromodulation is employed to convert the fast twitch skeletal muscle to slow twitch, resulting in relatively tonic contraction. (With permission from Baeten C, Breukink S. Dynamic graciloplasty. In: Wexner SD, Fleshman D (eds). Master Techniques in Surgery. Colon and Rectal Surgery. Anorectal Operations. Wolters Kluwer, Philadelphia, 2012)

Gluteoplasty

Using the gluteal muscles in a similar fashion to the gracilis muscle in the graciloplasty, functional skeletal muscle is wrapped around the sphincter complex. Contraction of the new

sphincter complex is achieved during ambulation. There has been marginal success with this surgery.

Artificial Bowel Sphincter (ABS)/ Magnetic Anal Sphincter (MAS)

Healthy patients with severe FI despite trial of other modalities and sufficient healthy soft tissue surrounding their anal canal can be considered for sphincter replacement. Compared to the surgical sphincter reconstruction, replacement of the sphincter through artificial implantable devices may be more appropriate in the otherwise healthy patient who has failed medical management, SNS, and undergoes EAUS to demonstrate an unreconstructable sphincter. Contraindications include history of pelvic irradiation, IBD, diabetes, and immunosuppression.

The ABS is an inflatable cuff tunneled and fixed around the anal canal through perineal incisions. The cuff is kept full during resting state to retain continence and when the patient needs to evacuate, he or she can actively pump fluid from the cuff to the reservoir implanted in the space of Retzius through a pump within the labia majora or scrotum. The cuff then passively refills with fluid after evacuation over 8–10 min.

This modality has been plagued with unreliable success and unacceptably high rates of complications—both related to patient morbidity and device failure. Although highly effective in certain cases, it is no longer currently available in the United States.

The magnetic anal sphincter (MAS) is a device consisting of small magnets on a flexible string. This is implanted around the anal sphincter, tunneled optimally just below the puborectalis muscle. The number of magnets is selected by the surgeon to provide complete occlusion of the anal canal as they are attracted to each other at rest. During defecation, Valsalva pressure forces the magnets apart, allowing the stool bolus to be evacuated. Unfortunately the MAS is not available in the USA at the time of publication.

J. Ostomy

Patients with fecal incontinence refractory to all other interventions may be offered stoma formation as it can ameliorate perianal hygiene difficulties and provide more manageable control of fecal material. Patients who are wheelchair-bound or paraplegic may desire this option because the location of the stoma is easier to take care of independently. An end sigmoid colostomy should be considered in most patients, except those with slow colonic transit time. Patients with chronic constipation or slow colonic transit time are likely better served by creation of an ileostomy. Satisfaction rates in patients with FI who receive an ostomy are high.

*Other Therapies

The following therapies have shown some promise as less invasive methods for improving fecal incontinence, but require further long-term study. These should be considered in patients who are not interested in SNS or desire non-surgical options.

Injectables

Surgical repair of internal anal sphincter defects has not been shown to be effective in isolation, and thus injection of biocompatible material into the intersphincteric or submucosal plane has been used for the treatment of minor fecal incontinence. The therapeutic goal is aimed at increasing the bulk of tissue in the anal canal, resulting in more effective physical occlusion. A number of materials have been used including autologous fat, collagen, non-animal stabilized dextranomer in hyaluronic acid (NASHA Dx - Solesta®; Salix Pharmaceuticals, Raleigh, NC), and carbon-coated beads (Durasphere EXP®, Coloplast Corp., Minneapolis, MN). Ultrasound-guided delivery of the bulking agents has been shown to be more effective than digitally-guided injection. Durable effi-

cacy has been demonstrated with Solesta at 24 and 36 months with over half of patients experiencing a greater than 50% reduction in the number of FI episodes. However, long-term studies are needed.

RF Remodeling

The Secca® procedure involves the delivery of radiofrequency energy as an alternating current to generate thermal energy within the anal canal to induce collagen fiber remodeling within the sphincter complex. The initial therapy was based on the theory that scarification causes a relative physiologic obstruction, thus improving control, however, interestingly, newer studies involving histologic assessment of tissue after RF therapy has revealed that the previously damaged sphincter muscle actually becomes more normal appearing after remodeling rather than simply forming scar.

Conclusion

In summary, a detailed history can often reveal the etiology of fecal incontinence in patients and all therapy should be individualized based upon the cause when possible. The majority of patients will improve with non-surgical management of diet modification, fiber supplementation and anti-diarrheal, slowing medications. The remainder of patients may benefit from one or more of the surgical interventions described, which should be tailored to the etiology of the FI and the wishes and comorbidities of the patient. Sacral nerve stimulation has emerged as a reliable treatment for a number of cause of FI and should be incorporated in the armamentarium of the Colorectal surgeon. Knowledge regarding all of the techniques available is important in this often underdiagnosed and difficult to treat problem.

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34 Pelvic Floor Conditions: Diarrhea

Rebecca Rhee and Anna Serur

Refer to Algorithm in Fig. 34.1

A. Pelvic floor dysfunction refers to a broad group of disorders that are caused by abnormalities in the muscles and joints of the pelvic floor (Table 34.1). Patients can present with defecatory problems with either inability to empty or to store the stool, pelvic pain or pressure and occasionally gross organ protrusion. Fecal incontinence, although not life threatening, can lead to significant disability and psychological trauma. It is more prevalent in the elderly and in hospitalized individuals. The prevalence of fecal incontinence in the non-institutionalized patients in the United States is estimated to be 8.3%, and consists of liquid stool in 6.2%, solid stool in 1.6%, and mucus in 3.1%. It occurs at least weekly in 2.7%, with 0.9% of patients experiencing it daily. Loose or watery stools are an independent risk factor in both men and women.

B. Fecal incontinence is defined as accidental passage of stool or mucus from the rectum without patient's knowledge, or without voluntary contraction, or both. Diarrhea is a very common cause of fecal incontinence. When a patient develops diarrhea, the colonic transit time is increased and the anorectal sensation may be diminished leading to quick evacuation. Fecal incontinence with diarrhea may occur even in patients with intact sphincters and no neurologic dysfunction. Anal sphincter pressure has to be much higher in order to hold the liquid stool and allow for controlled evacuation.

C. Evaluation of patients with fecal incontinence and diarrhea include a thorough history and physical exam, including obstetric history, other co-morbid conditions, history of injury to the sphincters, neurologic insults as well as the duration of symptoms, history of travel, dietary habits. A physician evaluating a patient with fecal incontinence may request the patient to keep a stool diary. A sample may be found on a website www.bowelcontrol.nih.gov. Another tool to evaluate patients with fecal incontinence and diarrhea is the validated Bristol Scale (Fig. 34.2). The validated Bristol Stool scale consists of seven descriptions of stool characteristics and helps to objectively determine the patient's stool consistency. It is friendly to use and includes pictures of each stool type.

D. The first step in the evaluation of diarrhea is to rule out an infectious cause. Stool cultures should be tested for ova and parasites, CMV

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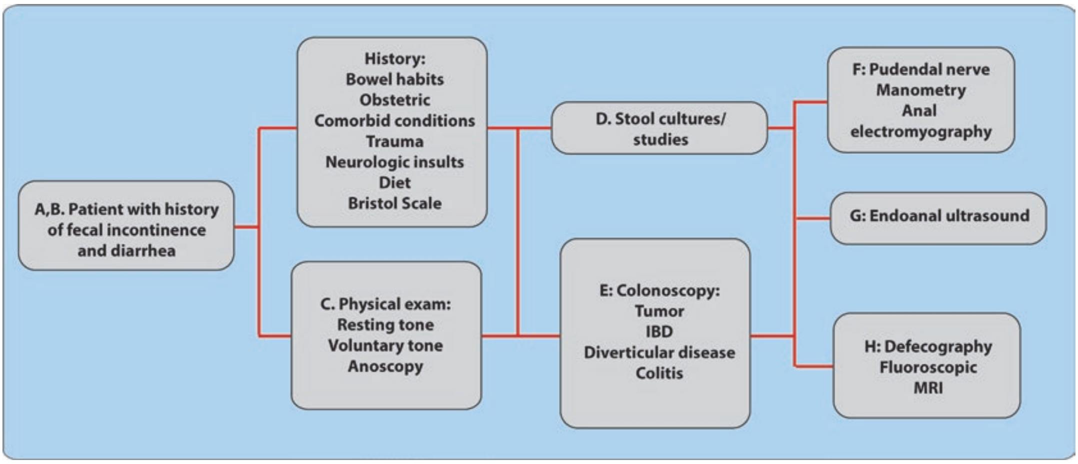

Fig. 34.1 Diarrhea evaluation algorithm. *IBD* inflammatory bowel disease

Table 34.1 Causes of pelvic floor dysfunction

Fecal incontinence
Constipation
Rectocele
Paradoxical puborectalis contraction
Pelvic pain syndromes:
Levator syndrome
Coccydynia
Proctalgia fugax
Pudendal neuralgia

and bacterial infections. Additionally, fecal leukocytes can indicate an infectious or inflammatory condition. *C. difficile* may be separately tested for one of the available stool studies (e.g., toxin, PCR).

E. Fecal incontinence with diarrhea may be caused by a rectal mass or a large rectal polyp. It is essential that the patients with FI have either a full colonoscopy or a sigmoidoscopy if a full colonoscopy was performed within a year.

F. There is a battery of tests used to evaluate patients with fecal incontinence. Anal manometry, PTNML, and anal electromyography are very helpful in trying to determine treatment for a particular patient. Anal manometry is used to evaluate the resting and squeeze pressures of the sphincter muscles as well as rectal compliance and rectal capacity. There are poor established parameters for normal pressures. According to the Cleveland Clinic Florida-Fecal Incontinence Scale (CCF-FIS), normal resting pressures are 40–70 mm Hg (55–95 cm water). Normal squeeze pressures are 100–180 mm Hg (136–244 cm water). Women generally have lower resting and squeeze pressures than men. There is no correlation between low pressures and surgical outcomes. However, pressures can be used for comparisons before and after therapy. Pudendal nerve terminal motor latency (PTNML) is another test used for evaluation of patients with fecal incontinence. It assesses the neuromuscular integrity of the pelvic floor by measuring the length of time required for a fixed electrical stimulus to conduct along the pudendal nerve and cause muscle contraction. Normal latency is considered to be 2 ms (SD, 0.2 ms). Latency is prolonged in patients with damage to the neuromuscular unit. The PTNML appears to be the most significant predictor of functional outcome after sphincteroplasty. In patients with a neurologic condition or insult, anal electromyography can quantitate the sphincter dysfunction. It can assess the extent of damage secondary to the neurologic condition and help in identifying other conditions responsible for fecal incontinence. Needle electrodes are inserted directly into the sphincter muscle and the patient is asked

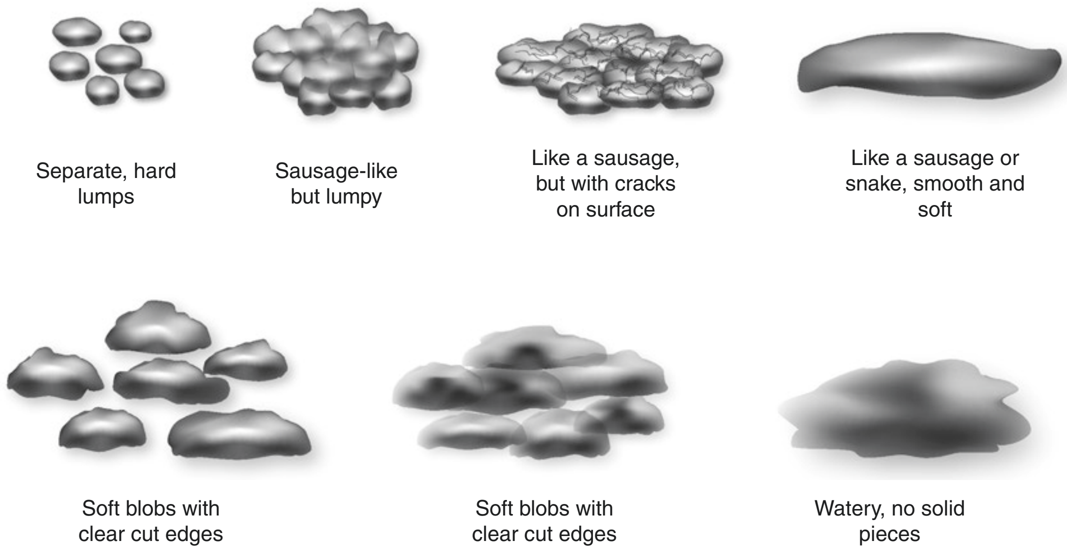

Fig. 34.2 Bristol Stool Scale. The seven types of stool are (1) Type 1: Separate hard lumps, like nuts (hard to pass), (2) Type 2: Sausage-shaped, but lumpy, (3) Type 3: Like a sausage but with cracks on its surface, (4) Type 4: Like a sausage or snake, smooth and soft, (5) Type 5: Soft blobs with clear cut edges (passed easily), (6) Type 6: Fluffy pieces with ragged edges, a mushy stool, and (7) Type 7: Watery, no solid pieces, entirely liquid

to contract the muscle as when holding a stool and then relax it.

G. Endoanal ultrasound is a great tool to assess the external and internal sphincter muscle. It gives a real-time, 3-D picture and has a very high specificity and sensitivity, 98–100% for the external sphincter and 95.5% for the internal sphincter. Three regions are examined: the most distal anal canal where only the external sphincter muscle is present, the mid anal canal visualizing both internal and external sphincter and the proximal anal canal-the level of the pubococcygeus muscle. The normal thickness of the external sphincter muscle is ~8.3 mm (95% confidence interval [CI], 7.6–9 mm). Mean internal anal sphincter thickness is described as 6.5 mm (95% CI, 5.8–7.2 mm). Tjandra and colleagues found EAUS to be more accurate than EMG in evaluating sphincter defects and more comfortable for the patient.

H. Defecography or MRI defecography is used to evaluate rectal emptying as well as ability to be able to hold the stool. While not a traditional component of a diarrhea evaluation, It may be helpful in diagnosis of rectal prolapse, rectocele, cystocele and internal prolapse—conditions that can lead to symptoms of diarrhea. Most patients with incontinence have a hard time tolerating this procedure. A pelvic mass can cause an extrinsic compression on the rectum, causing urgency and incontinence. Pelvic MRI is an excellent tool in diagnosing this problem.

Refer to Algorithm in Fig. 34.3

I. Treating the cause of diarrhea, increasing the consistency of the stool and slowing down the transit time may lead to improvement in patient's fecal incontinence. Treatment of fecal incontinence with diarrhea ranges from dietary modification to anti-diarrheal medicine to surgical options. Medical management should be exhausted prior to recommending surgical alternatives.

J. Dietary modification is the first step in treatment of diarrhea. Patients should avoid foods such as dairy products, caffeine, spicy foods, and should increase intake of fiber-rich foods, including fruits, vegetables, nuts and

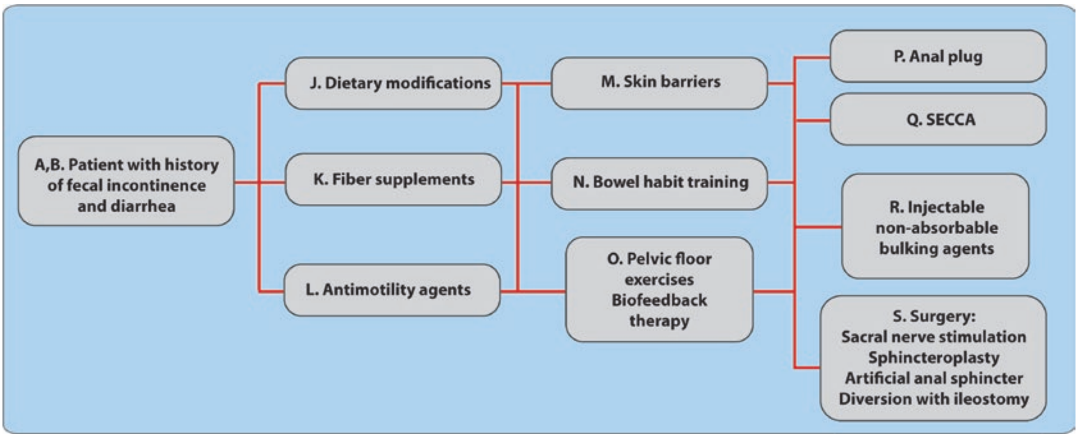

Fig. 34.3 Diarrhea management algorithm

whole grains. A diet should include soluble and insoluble fiber and adequate amount of fluids.

K. Patients should be instructed to take a fiber supplement such as Metamucil, Fibercon, Benefiber, etc. As each of these vary in their taste, consistency, and amount of fiber per scoop/pill/wafer, it is important to ensure patients are instructed in goals for intake.

L. Constipating medicines such as Loperamide or diphenoxylate with atropine are the next step in treating incontinence with chronic diarrhea. Both of these medications can be given up to 4 times a day, 30 min before meals, and once before sleep. Cholestyramine and Tincture of Opium can be added to the regimen if Loperamide and diphenoxylate with atropine fails to solidify the stool. Ondansetron has been shown to be effective in Irritable Bowel Syndrome with diarrhea. In a randomized, double-blind, placebo-controlled trial of 120 patients with Rome III criteria for diarrhea-predominant irritable bowel syndrome, 4 mg dose led to improved stool consistency, decreased number of days with urgency, improved urgency scores, and decreased frequency of defecation. Amitriptyline is another drug that improves diarrhea and decreases rectal urgency.

M. Skin barriers and creams should be used to decrease secondary morbidity of diarrhea. Balneol lotion and Calmoseptine ointment are very effective in creating a protective barrier and avoiding irritation and skin break down. Patients should be counseled about avoidance of wipes and prolonged use of steroid creams.

N. Developing a regular bowel routine is referred to as bowel training. Bowel training is a difficult task for patients who have diarrhea and takes weeks to months to develop but is possible. It works very well in patients with constipation and overflow incontinence. Daily enemas or rectal washout can be done daily or twice a day in order to facilitate bowel training.

O. Pelvic floor exercises and biofeedback therapy uses audiovisual cues to change patient's bowel habits. It requires a motivated patient and a motivated therapist. Very few studies have been done to support its efficacy. Many different techniques have been described leading to inconsistent treatment, and the evidence for long-term effect is poor.

P. Anal plug is another modality that can be used to improve patients' quality of life but not to eliminate the problem. A Cochrane review of four studies with 136 patients noticed improvement in patients with minor leakage. However, approximately one-third of patients did not tolerate the plug, discontinuing its use.

Q. SECCA procedure was introduced in 2002. It involves application of temperature-

controlled radiofrequency energy to the anal canal. The mechanism of its action is not clear but it does improve the sphincter function and anorectal sensitivity. A review of 10 studies with 200 patients demonstrated its efficacy in mild to moderate incontinence with improvement in CCF/Wexner incontinence and quality of life scores.

R. Non-absorbable bulking agents injectable (Solesta) is composed of sodium hyaluronate and dextranomer. It was approved by the FDA for the treatment of fecal incontinence in 2011. It is injected into the submucosa of the upper anal canal bulking it up. The compound also promotes fibroblast and collagen growth. In a multicenter study, 62.7% of patients experienced more than 50% reduction in both solid and liquid stool incontinence episodes. NASHA/Dx was found to be effective and safe over a 24-month period.

S. Depending on the etiology of incontinence, surgery can be the primary modality or the treatment of last resort. Neuromodulation, overlapping sphincteroplasty, artificial bowel sphincter and diversion with ileostomy/colostomy are existing options for patients.

Fecal Incontinence is a chronic life-long disease that can be a result of congenital or acquired conditions. The goal of treatment is to improve patient's quality of life and not necessarily cure the disease. The most frequent type of Fecal Incontinence is the loss of liquid stool. Chronic diarrhea is a factor that can be modified by patients with fecal incontinence leading to better control and thus better quality of life.

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35 Chronic Constipation

Paula I. Denoya and Syed K. Abbas

Introduction

Constipation is one of the more prevalent gastrointestinal complaints in the general population. One out of six adults suffers with this condition in varying degrees. According to the Rome IV criteria, constipation is defined as the presence of two or more of the following symptoms that occur in more than 25% of defecations: straining during defecation, sensation of stool in the rectal vault after defecation, sensation of obstruction or blockage, passage of lumpy and/or hard stools, need for manual maneuvers to facilitate defecation (such as digital evacuation and perineal support during defecation), and less than three spontaneous bowel movements per week. These symptoms must be present for at least three months with onset of symptoms at least six months prior to diagnosis. In patients with irritable bowel syndrome, the criteria for constipation have not been clearly defined. Patients do not meet the criteria of constipation if they exhibit symptoms of irritable bowel syndrome, such as abdominal pain that is relieved with defecation, unpredictable stool frequency, and variable stool forms with defecation (varies between diarrhea and hardened stool). Furthermore, patients with constipation rarely have loose stools without the use of laxatives.

The most common causes of constipation are insufficient fluid or fiber intake and poor bowel habits. When examining the other causes, constipation can be categorized into primary and secondary causes. Primary causes of constipation are divided into normal transit constipation (NTC), slow transit constipation (STC), and defecatory disorders.

In NTC, patients will report symptoms of constipation while having normal passage of stool through the colon. The symptoms in NTC tend to be associated with psychosocial stress.

In STC, patients have normal colonic transit at rest, but have decreased or absent colonic motility after meals or blunted responses to laxatives and cholinergic medications. It is suspected that there is a possible dysfunction in the enteric nerve plexus or the interstitial cells of Cajal.

Defecatory disorders are characterized by abnormalities in the pelvic floor muscles. Dyssynergia is the impaired relaxation or inappropriate contraction of the puborectalis and external anal sphincter muscles during defecation. When these muscles contract, the anorectal angle is narrowed, increasing the anal canal pressures and preventing effective defecation. Abnormally elevated resting pressures in the anal canal due to anal sphincter muscle spasms defines anismus, which can also cause constipation. Structural abnormalities, such as megacolon and megarectum, can fall

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under defecatory disorders. The dilation and distension of the colon or rectum can be attributed to neurologic dysfunction or chronic fecal retention and impaction (Table 35.1).

There are a wide variety of secondary causes of constipation. The most common manifestations of secondary constipation are multifactorial and involve multiple organ systems, including neurologic, psychiatric, metabolic, endocrine, autoimmune, and congenital. Furthermore, mechanical obstructions from benign and malignant pathologies can present as constipation, such as rectoceles, rectal prolapse, intussusception, colonic lesions like adenocarcinoma and polyps, and colon or anorectal strictures. Medications that cause constipation as a side effect are analgesics, anticholinergics, neurally active drugs, cation-containing agents, and diuretics.

Refer to Algorithm in Fig. 35.1

Diagnosis

A. History

When obtaining the history from a constipated patient, it is important to define the nature and the duration of constipation. Some of the most common complaints in constipated patients include abdominal bloating, pain with defecation, rectal bleeding, overflow diarrhea or incontinence, and lower back pain. Patients that have difficulty with rectal evacuation may complain of a sense of incomplete evacuation, manual extraction of stool, tenesmus, and enema retention. Other important aspects of the history should be explored, such as the patient's normal pattern of defecation, onset and duration of abnormal pattern, perceived hardness of stools, straining to defecate, and the amount of time spent during defecation. Obtaining a validated constipation score is useful both to help direct therapy and to monitor post therapeutic outcomes. The Cleveland Clinic Florida-Fecal Incontinence Score (CCF-FIS) is the most widely employed score.

Table 35.1 Etiology of constipation

Primary causes of constipation
Normal transit constipation
Slow transit constipation
Defecatory dysfunction
Dyssynergia
Megacolon/megarectum

Secondary causes of constipation	
Neurologic disorders	Medications
Peripheral disorders	*Analgesics*
Autonomic neuropathy	NSAIDs
Hirschsprung disease	*Anticholinergics*
Chagas disease	Antihistamines
Intestinal pseudoobstruction	Antispasmodics
Sacral nerve damage	Antidepressants
Central disorders	Antipsychotics
Multiple sclerosis	*Cation-containing agents*
Spinal cord injury	Iron supplements
Parkinson disease	Aluminum (antacids, sucralfate)
Endocrine disorders	Barium
Diabetes mellitus	*Neurally-active drugs*
Hypothyroidism	Opiates
Hyperparathyroidism	Antihypertensives
Panhypopituitarism	Ganglionic blockers
Metabolic disorders	Vinca alkaloids
Hypokalemia	Calcium channel blockers
Hypercalcemia	5HT3 antagonists
Uremia	*Diuretics*
Porphyria	
Myogenic disorders	
Myotonic dystrophy	
Dermatomyositis	
Scleroderma	
Amyloidosis	
Structural abnormalities	
Colorectal cancer	
Extraintestinal mass	
Postinflammatory, ischemic, or surgical stenosis	
Anal fissure	
Anal stricture	
Rectal prolapse	
Rectocele	
Intussusception	

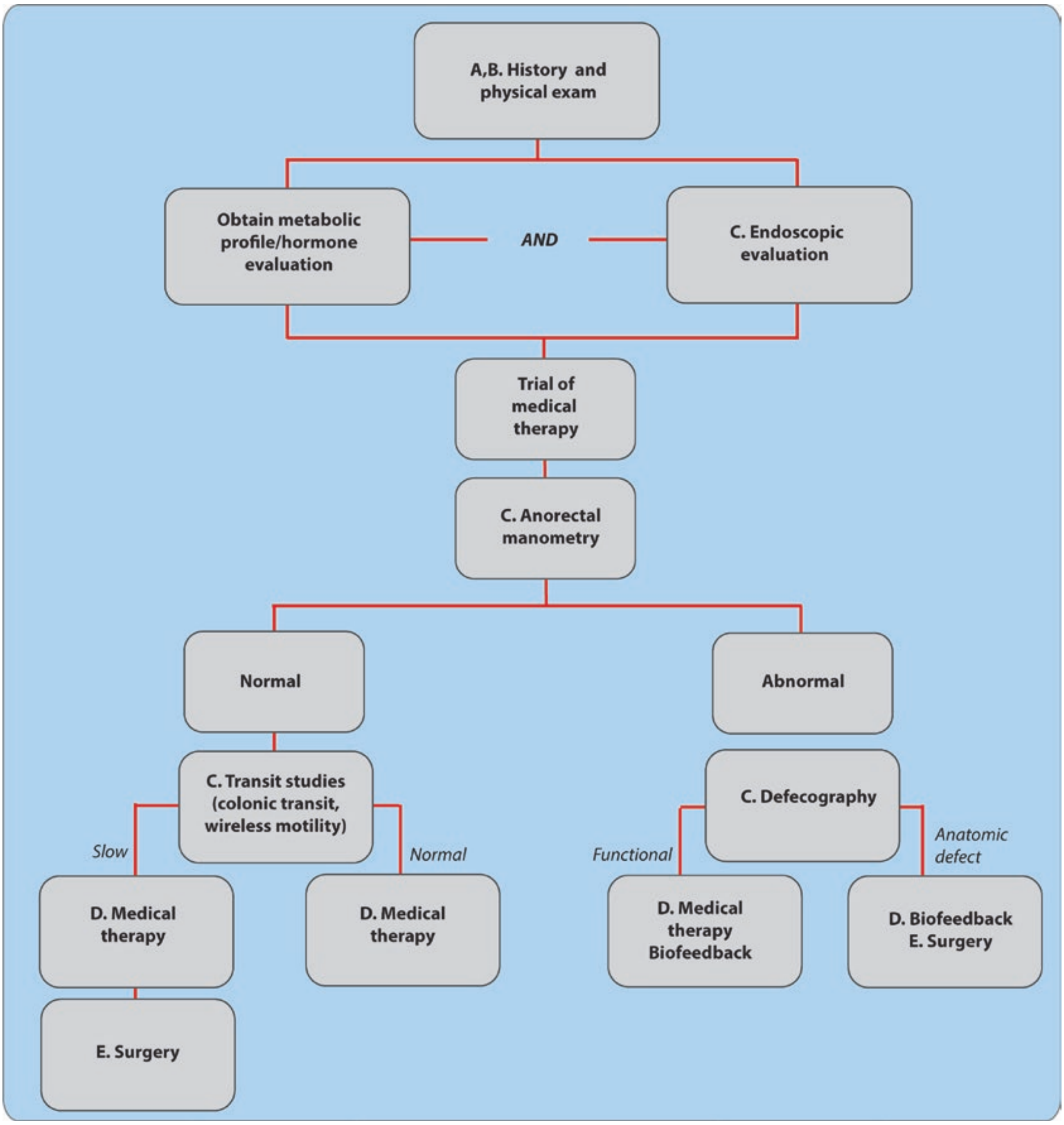

Fig. 35.1 Algorithm for chronic constipation

Initial evaluation would include assessment for causes of secondary constipation, including medications, metabolic disorders, neurologic dysfunction, endocrinopathies, and psychiatric disorders. In regards to drug history, it is important to note the temporal relationship between starting a particular drug and the onset of constipation. Rectal bleeding, abdominal pain, inability to pass flatus, vomiting, and unexplained weight loss are warning signs and symptoms that warrant evaluation for malignancy. After a complete assessment of secondary causes, one can better assess for primary causes of constipation.

B. Physical
A thorough general physical exam may provide some insight into the systemic causes of constipation. An abdominal exam can identify abdominal wall abnormalities, previous surgical scarring, and abdominal tenderness.

Rectal examination is very useful in this setting since it can be used to provide information regarding distal anorectal pathologies and assess pelvic floor function.

- The external evaluation of the anus allows the physician to detect anal fissures, hemorrhoids, cutaneous and mucosal lesions, and pelvic floor weakness. Evidence of pelvic floor descent, rectal prolapse, and anal stenosis can be seen on visual inspection. If rectal prolapse is suspected, the patient can be asked to Valsalva while sitting on a commode.
- During the digital rectal examination, the patient is assessed for rectal tenderness, mucosal abnormalities, sphincter function, and gross or occult bleeding via stool guaiac. A quick pelvic floor evaluation can be performed by having the patient Kegel and Valsalva with the examining digit in the anal canal. Rectocele or vaginal prolapse can be assessed at this time as well.
- If external visualization and digital exam are insufficient to make a definitive diagnosis, anoscopy can be used to visualize anal canal to evaluate for mucosal lesions, internal hemorrhoids, and anal fissures.

C. Diagnostic Studies

Labs

Basic bloodwork can be used to promptly identify hematologic, endocrine, and metabolic disorders. A complete blood count can be used to assess for anemia due to gross or occult rectal blood loss. Thyroid function tests can be ordered if a patient exhibits constipation with signs of hypothyroidism. Electrolyte abnormalities associated with constipation, such as hypokalemia and hypercalcemia, can be evaluated with serum chemistry tests. Laboratory blood tests are important to rule out these systemic causes of constipation during the initial evaluation of the patient.

Radiology

Radiographic tests assess the general condition of the colon in the setting of constipation by providing a baseline evaluation of the colonic anatomy.

Fig. 35.2 Abdominal plain films are usually the first line in imaging to detect significant stool retention in the colon and areas of distension such as megacolon. It can identify fecal impaction, bowel obstruction, and fecaliths. Plain films can also be used to monitor bowel cleansing in patients with fecal retention

- Abdominal plain films are usually the first line in imaging to detect significant stool retention in the colon and areas of distension such as megacolon. It can identify fecal impaction, bowel obstruction, and fecaliths. Plain films can also be used to monitor bowel cleansing in patients with fecal retention (Fig. 35.2).
- Barium and gastrografin studies are dynamic studies that provide information to evaluate anatomical causes of constipation. Contrast studies can give insight into distal colorectal conditions that contribute to luminal narrowing. Examples include congenital conditions, such as Hirschsprung disease, as well as obstructing colon cancer, intermittent volvulus, and colonic strictures.

Endoscopy

Endoscopy is the best initial test for evaluation of anatomical abnormalities as a cause of constipation. Available endoscopic modalities to identify colonic occlusions and strictures include rigid or flexible sigmoidoscopy and

colonoscopy. Endoscopic studies are used to evaluate inflammatory bowel disease, masses, malignancies, strictures, diverticular disease, and post-surgical anatomic abnormalities. Diagnostic colonoscopies should be prioritized in patients with constipation and at high risk of colorectal malignancies. These include patients who are over 50 years old and have had no precious colon cancer screening, younger patients with a positive family history of colon cancer, and patients who present with alarm features of malignancy.

Colon Transit Studies

Colon transit studies are most useful in evaluating patients with infrequent defecation. Specifically, these studies are indicated for patients with chronic constipation in order to differentiate between slow and normal colonic transit after they have failed conservative management with diet changes and laxatives. The following tests measure the colonic transit time which is defined as the time it takes for stool to pass through the colon.

- Radiopaque marker studies measure the colonic transit time by following the passage of radiopaque markers as they travel through the gut as monitored by serial abdominal radiographs. Routinely, the patient will swallow a capsule with 24 markers on day 1 and is followed by abdominal x-ray up to day 5 (after 120 h). The patient should abstain from laxatives during the duration of the test. The test is considered abnormal if there is retention of more than five markers on day 5. Based on the pattern of marker movement within the colon, patients can have normal colonic movement, slow transit constipation if markers are retained in the right or transverse colon, or outlet obstruction (dyssynergia) as markers progress normally through proximal colon and stagnate in the sigmoid colon and rectum.
- Wireless motility capsule studies are useful for assessing regional transit time (gastric emptying, small bowel transit, colon transit) and whole gut transit time. The patient swallows a capsule that is used to measure the pH and pressures of the gut as it travels through the digestive tract. The patient wears a wireless receiver until the capsule is expelled. Wireless motility capsule studies are well tolerated, has good compliance, and avoids the risks of radiation exposures. These studies are more expensive and augment additional findings of motility dysfunction. Sensitivity and specificity are similar when comparing these two methods.

Motility Studies

Motility studies are done to evaluate defecatory disorders that involve rectal sensation and compliance, internal and external anal sphincter and puborectalis function, and motility patterns during defecation. They can also be used to assess the response to biofeedback therapy as discussed later in this chapter.

- Endorectal ultrasound is an imaging modality that allows one to assess submucosal lesions, anatomical sphincter defects, and the presence of fistulae and deep abscesses in the distal anorectal region. An ultrasound probe is introduced into the anal canal, providing a circumferential image of the rectal mucosa and perirectal tissues.
- Anorectal manometry is performed by placing a balloon with pressure sensors in the rectum and measuring the intrarectal pressure and external sphincter pressure as the patient attempts to evacuate the manometer. Normally, there is an increase in intrarectal pressure and a decrease in external sphincter pressure during defecation. In patients with dyssynergia, there is a paradoxical increase in external sphincter pressure during defecation. Rectal sensation and compliance may also be assessed. The rectoanal inhibitory reflex (RAIR) should be tested, to evaluate for possible Hirschsprung disease. RAIR will be abnormal in Hirschsprung but also in patients with prior coloanal anastomosis or other surgery involving the anorectal canal.
- Balloon expulsion tests can be used as a simple office screening for defecatory dysfunction. In this test, a water filled balloon is placed in the rectum to stimulate stool and the patient is told to expel the

balloon. The test is normal if the balloon is expelled in less than one minute and is abnormal if it takes more than two minutes to expel the balloon. Balloon expulsion tests should be used in addition to other more rigorous tests of anorectal function.

Defecography

Defecography evaluates for anorectal obstruction due to mechanical lesions and physiologic muscular dysfunction. The test is done by placing barium paste in the patient's rectum and instructing the patient to bear down while sitting on a radiopaque commode. During evacuation, the barium paste is monitored by fluoroscopy. The test can be modified to involve MRI in order to evaluate the global pelvic floor anatomy, sphincter morphology, and the dynamic motion during defecation. MRI is more expensive and in most instances is performed in the supine position, which is not as physiologic as a sitting defecogram. However, fluoroscopic defecography is becoming less available in many locations and is being replaced by MRI defecography. MRI has the added advantage of evaluating the anterior and middle pelvic compartments simultaneously with the posterior compartment, and avoids radiation exposure.

Rectal Biopsy

Rectal biopsy is done to assess for areas of reduced or absent ganglionic activity within the colon. Although this test is done more often in neonates and infants with delayed meconium passage, it may be done for adults with suspected undiagnosed Hirschsprung disease. In infants and young children, a suction biopsy is performed by a device that applies a suction cup to the wall of the colonic mucosa, then introduces a knife to dissect a sample of the mucosa and submucosa for histological analysis of ganglionic cells. Alternatively, a transanal biopsy without suction may be done in older children and adults. The biopsy should be done about 2 cm proximal to the dentate line to ensure obtaining rectal mucosa and submucosa. A standard colonoscopic biopsy forceps should not be used as submucosa is needed for the diagnosis.

Management

D. Medical Management

Initial Management

Initial treatment for constipation in adults involves patient education regarding dietary changes and appropriate bowel habits.

- Patients should increase their fiber intake to 20–35 g per day. Potential side effects include increased bloating, mild abdominal distension, and increased flatulence.
- Patients should also increase their fluid intake to the recommended eight glasses of water per day. Furthermore, caffeine drinks and diuretics should be avoided since decreased available water in the body can contribute to the development of constipation.
- In addition, patients are instructed to attempt defecation during periods of increased colonic activity, such as after meals and in the morning.
- Patients with obstructed defecation may benefit from placing their feet on a stool or box while defecating on the toilet to raise the knees above the hips to simulate squatting.

Pharmacologic Treatment

Besides lifestyle changes, pharmacologic therapy may be used to augment initial conservative management by softening stool to facilitate defecation.

- Bulk-forming laxatives are natural or synthetic polysaccharides/cellulose derivatives that absorb water and increase fecal mass, increasing the frequency of defecation and softening the consistency of stools. These stool softeners must be used on a long-term basis since it takes time for water to be passively absorbed into the stool. These include agents containing psyllium or other "fiber supplements."
- Surfactants work by lowering the surface tension of feces, allowing water to be passively absorbed to soften the stool.
- Osmotic agents are nonabsorbable materials that draws water into the colon via the osmotic effect. This increases intestinal

water secretion which softens stool and increases stool frequency. This includes agents containing polyethylene glycol.

- Stimulants act by altering electrolyte transport in the intestinal mucosa and by stimulating the intestinal motor activity, increasing intestinal secretion and motility. This category includes medications containing senna or bisacodyl.
- Lubiprostone is a C1C-2 intestinal epithelial chloride channel activator that increases intestinal fluid secretion.
- Linaclotide is a guanylate cyclase agonist that increases cGMP, anion and fluid secretion, and intestinal motor activity, similar in action to stimulant laxatives.
- Misoprostol is a prostaglandin analog that promotes intestinal motility.

The decision regarding a specific laxative depends on patient tolerance and physician preference. Other methods of medical management include suppositories and botulinum toxin injections. These options are usually saved until the constipated patient fails the previously described medical management. Glycerin or bisacodyl suppositories act by liquefying stool to bypass any defecatory dysfunction. Botulinum toxin is used rarely for patients with pelvic floor dysfunction by injecting a small amount of toxin in the puborectalis muscle, allowing the muscle to relax and relieving the defecatory dysfunction. This method require repeated treatments in order to prevent recurrence of constipation.

Biofeedback Therapy

Patients with dyssynergia can be treated with biofeedback therapy, which uses behavioral training to correct inappropriate pelvic floor muscle and sphincter contraction. Biofeedback therapy uses electromyography or manometry to provide feedback on sphincter muscle function during defecation to allow the patient to adjust pelvic floor muscle contraction. Other techniques include the use of an inflatable balloon in order to simulate the passage of stool. The balloon is inflated until the patient feels the urge to defecate and the patient attempts to expel the balloon. Biofeedback therapy helps relieve dyssynergic constipation without the use of laxatives.

E. Surgical Management

Manual and Endoscopic Disimpaction

Surgical options are available for patients that fail conservative medical management of constipation. These procedures are mainly for those suffering from slow transit constipation and rectal outlet obstruction. Patients with fecal impaction may undergo disimpaction, which involved manual fragmentation of stool followed by mineral oil enema for stool softening and colonic lubrication. If the constipation continues despite disimpaction, a water-soluble contrast enema may be indicated to assess for obstructions and proximal impactions. Flexible or rigid sigmoidoscopy can be used to fractionate the proximal impactions followed by either warm water enemas or polyethylene glycol solutions for bowel cleansing.

Surgeries for STC

There are several procedures for patients with slow transit constipation.

- The most radical procedure is an abdominal colectomy with ileorectal anastomosis. The entire colon is resected at the proximal rectum with an ileorectal anastomosis. Other options include leaving a segment of colon proximal to the rectum such as an ileosigmoid anastomosis, to decrease risk of an anastomotic leak and diarrhea. It is extremely important to rule out pelvic floor dysfunction prior to colectomy, as this may lead to continued constipation, possibly requiring an ileostomy.
- A segmental colectomy can be performed for patients that have a small dysmotile colonic segment, such as adult Hirschsprung disease.
- In patients who have slow transit constipation and are unable to tolerate a colectomy can opt to have an antegrade colonic enema. This procedure, done rarely in adults, creates an appendicostomy with a valve mechanism to allow for catheterization of the appendix for enema fluid.

Surgeries for Rectal Outlet Obstruction

- Patients with rectal outlet obstruction may suffer from rectal intussusception, rectocele, or rectal prolapse.
- Rectocele repair is indicated when the rectocele is 3 cm or more in depth, defecography demonstrates significant barium trapping, or the patient requires digitation for adequate evacuation. Several options for rectocele repair include transvaginal posterior colorrhaphy, transanal posterior repair, transperineal repair, or transabdominal repair.
- Rectopexy is indicated for patients with a complete rectal prolapse. This procedure involves mobilizing the rectum and securing it to the sacrum, therefore reducing the prolapse. Additionally, a sigmoid colon resection may be added in patients who have underlying constipation, but is not necessary in the nonconstipated patient. Pexy may be done with sutures or with mesh. In addition, there are several resection techniques for rectal prolapse that can be offered for elderly patients that cannot tolerate abdominal surgery.
  – Mucosal proctosigmoidectomy (Delorme's procedure) is specific mucosal prolapse and small rectal prolapse, and involves excising the mucosa of the prolapsed rectum in order to plicate the underlying muscle wall and reduce the rectum back into the pelvis.
  – Perineal proctosigmoidectomy (Altemeier procedure) is indicated for patients with complete rectal prolapse who wish to avoid abdominal surgery. In this transanal procedure, the prolapsed rectum is incised, the redundant colon is resected, and then the colon and distal rectum are anastomosed.
  – Finally, the stapled transanal rectal resection (STARR) procedure is offered for elderly patients with rectoceles or intussusceptions. This operation uses two circular staplers to perform a circumferential transanal resection of the rectum, effectively resecting the rectal outlet obstruction.

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Part IV

Rectal

36 Retrorectal Tumors

Eric G. Weiss and Luanne Force

Refer to Algorithm in Fig. 36.1

A. Presentation
   Retrorectal tumors encompass a heterogeneous group of tumors located in the presacral, or retrorectal space. The boundaries of the retrorectal space are the presacral fascia posteriorly, the rectum anteriorly, the rectal stalks, iliac arteries and ureters laterally, Waldeyer's fascia inferiorly and the peritoneal reflection superiorly. Lesions may be categorized as congenital, neurogenic, osseous, or miscellaneous. These are rare tumors, accounting for 1/40,000 hospital admissions. Most often, a retrorectal tumor will present as an incidental finding on imaging for another cause approximately 50% of the time. In patients that are symptomatic, the symptoms are often vague. Low back pain, leg pain or vague rectal pain may be present. There may also be compression of the sacral nerves that might present as incontinence, or pain that radiates to the buttocks and/or legs. Alternatively, these may present with signs of acute or chronic infection, as an abscess or fistula to the perirectal or perianal space.

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Evaluation

B. History and Physical Examination
   A detailed history and physical examination is important when evaluating patients with retrorectal tumors. These tumors are rare, often presenting with vague signs and symptoms, so a high level of suspicion must be maintained. The patient may present with a palpable rectal mass and be completely asymptomatic. Other signs/symptoms may include back pain, perineal pain, constipation, and vague gynecologic complaints in women. Neurologic complaints secondary to nerve impingement may also be present, including lower extremity pain. Infection of the lesion may present as chronic sinuses, recurrent pilonidal infections, drainage into the rectum or vagina. Some female patients may present after a difficult vaginal delivery secondary to vaginal canal obstruction. Patients may have vague complaints for years without a diagnosis. Physical examination should include a thorough inspection of the perineal skin and soft tissue, looking for any chronic sinuses or fistulae. A skin dimple may be observed posterior to the anus. A soft, smooth extrarectal mass may be palpated on digital rectal exam.
C. Imaging Modalities
   A variety of imaging modalities may be used to assess retrorectal tumors, including plain radiographs, CT scanning and

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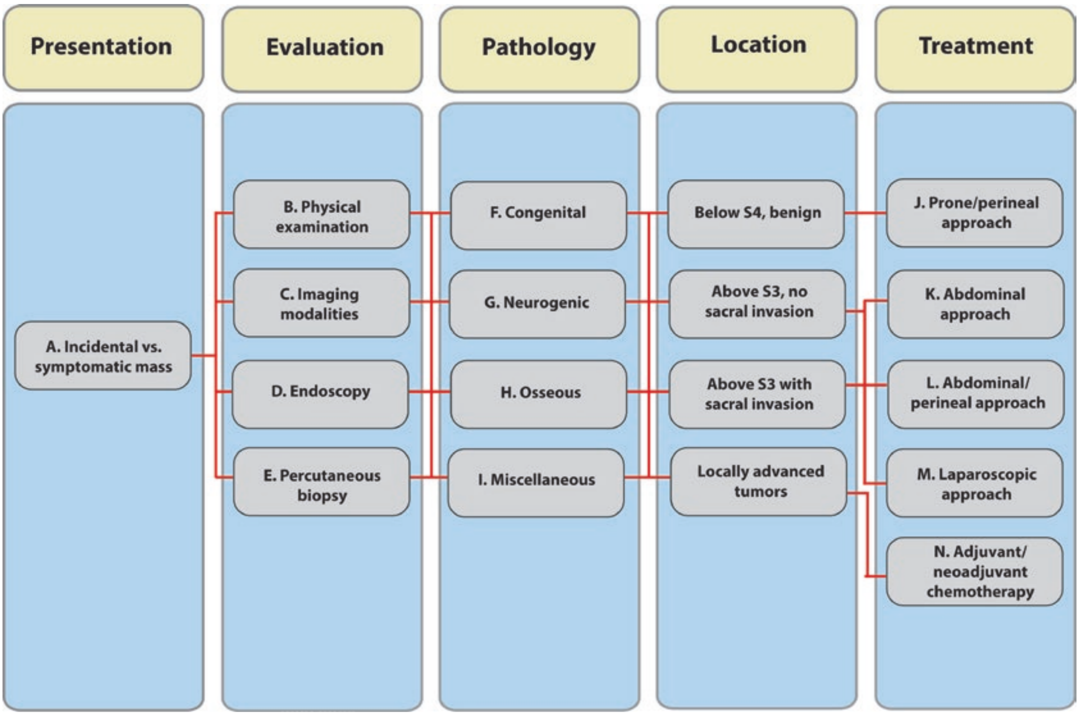

Fig. 36.1 Algorithm for retrorectal tumors

MRI. Several "hallmarks" on imaging may suggest a certain tumor. A plain radiograph of the pelvis may show evidence of bony destruction, which may indicative of a chordoma or malignant lesion. Multiple areas of calcification could signify a teratoma. A "Scimitar" sign consists of the sacral border appearing to be rounded without bony destruction, which is seen in sacral meningocele. MRI has been shown in multiple series, such as Glasgow and colleagues, to be superior to CT to evaluate retrorectal masses. MRI can delineate the size, location of the tumor, and any invasion into surrounding structures and provides better contrast enhanced image. Features of the lesion on MRI imaging may give some clue as to the etiology and origin of the tumor. The presence of fat within the lesion on MRI may be indicative of a teratoma, dermoid cyst, liposarcoma, lipoma, myelolipoma or extramedullary hematopoiesis. Non-fatty containing solid lesions may be categorized as cystic or solid. Solid masses include nerve sheath tumors (*e.g.*, schwannoma or neurofibroma), myxoma, metastasis or lymphoma. If there is evidence of sacral invasion, the lesion may be a sacrococcygeal chordoma or another osseous tumor. Non-fat containing cystic masses can be categorized as tailgut cysts, cystic hamartomas, rectal duplication cyst, epidermoid cyst, anterior sacral meningocele, or extramucosal mucinous adenocarcinomas.

D. Endoscopy

Endoscopy has a limited role in evaluating presacral tumors. Sigmoidoscopy or colonoscopy should be performed to exclude a primary rectal neoplasm. In the absence of a primary rectal cancer, endoscopy can be used to visualize the rectal mucosa and determine if the rectum is involved by the mass to aid with preoperative planning. Even when the mucosa is not directly involved, a smooth bulging may be seen related to mass effect of the tumor on the overlying rectal wall.

Endoanal ultrasound may be performed, but some difficulty in interpretation is often present, as these lesions are rare and the endosonographer may not be familiar with the different appearances identified. Since these tumors are rare, there is limited experience with ultrasound for evaluation, and often better evaluated by CT or MRI.

E. Percutaneous Biopsy

There is some debate in the literature about the importance and usefulness of preoperative biopsies of presacral masses. Many authors claim that there is a limited role for preoperative biopsy given the accuracy of MRI imaging. In addition, there have been some reports of seeding of the biopsy tract, which may lead to increased morbidity of subsequent procedures, as the tract or other organs that are in the path of biopsy may also need resection. Furthermore, biopsy of a meningocele may lead to fatal meningitis. Proponents for biopsy indicate that tissue diagnosis is more accurate and concordant with postoperative pathologic results in comparison with MRI alone. In addition, the presence of a malignant tumor may indicate a need for neoadjuvant therapy prior to surgical resection. Preoperative biopsy may guide therapeutic options for inoperable tumors or prior to operative intervention. A large, unresectable chordoma may benefit from high dose radiation therapy as a palliative option. Retrorectal sarcomas may also benefit from adjuvant treatment. GIST tumors may occur in the presacral space, which are amenable to treatment with imatinib. In general, biopsy should be individualized towards the goal of the biopsy. If therapy in addition to surgery is initially warranted, and pathological diagnosis is required, then biopsy may be performed. Moreover, if neoadjuvant therapy may allow for tumor shrinkage (e.g., GIST), the biopsy may be warranted. “Straightforward” lesions that are amenable to upfront surgical resection typically do not require biopsy.

Risk Assessment

Pathology: Four Tissue Types

F. Congenital

Congenital tumors are the most common subtype of retrorectal tumors, accounting for 50–70% of all patients. Developmental cysts are the most common congenital retrorectal tumors (Fig. 36.2). Majority of patients are female. These cysts may contain cells from any developmental cell type. Developmental cysts could be dermoid, epidermoid, tailgut or teratomas. Epidermoid cysts contain a squa-

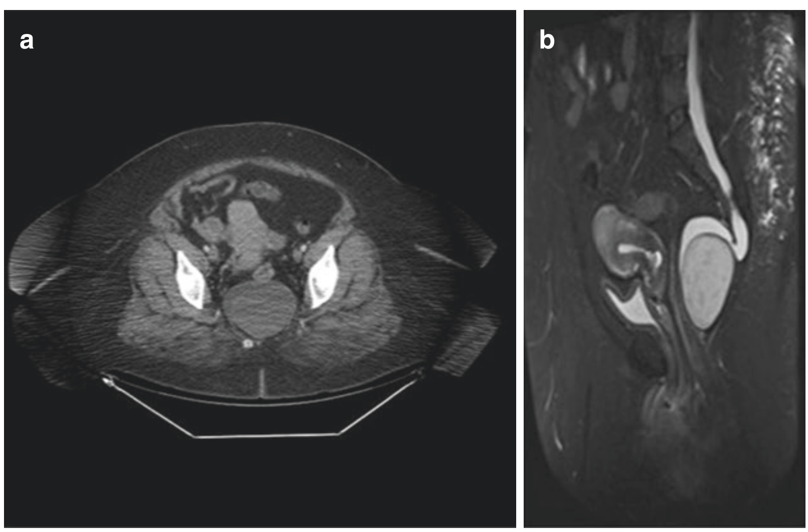

Fig. 36.2 (**a**) CT scan image of an epidermoid cyst. (**b**) Sagittal view. (Courtesy of Dr. Laurence Sands)

mous epithelial lining. Dermoid cysts are further differentiated, and contain dermal appendages such as hair and sweat glands. These lesions may present with a draining sinus or dimple in the post-anal area, which may be confused for an abscess. Tailgut cysts contain columnar epithelium, and may secrete mucus. Rectal duplication cysts are another type of congenital lesion. These cysts contain all cell types and structures of a normal piece of intestine. Teratomas contain cells that can differentiate into any cell type. These have a higher rate of malignant degeneration, 5–10%, when compared to other developmental cysts. When they degenerate, they may become adherent to the coccyx, rectum or other viscera.

Chordomas are the most common malignant presacral tumors (Fig. 36.3). They arise from the fetal notochord, 1/3 of the time they are located in the retrorectal space, however, they may arise anywhere along the spinal column. Chordomas are slow growing tumors, the majority will be detected at age 40–60 with a male predilection. As chordomas grow, they tend to invade surrounding structures which cause worsening pain, incontinence and neurogenic complaints. Since these tumors are locally aggressive, recurrence is noted in up to 44% of patients after resection. A radical resection of all affected tissue is indicated, which would include wide margins and resection of any involved structures *en-bloc*.

Anterior sacral meningocele occurs when the dural sac herniates through a defect in the sacrum (Fig. 36.4). The sac communicates with the subdural space and contains CSF. More commonly found in women, these may present with patients complaining of a headache during defecation. They may also present as life threatening meningitis. A sacral meningocele may be diagnosed by plain radiograph by the presence of a Scimitar sign, again characterized by the rounded appearance to the sacrum. It is very important that the dura be repaired during resection of these tumors. Failure to do so will result in CSF leak or infection of the dural space.

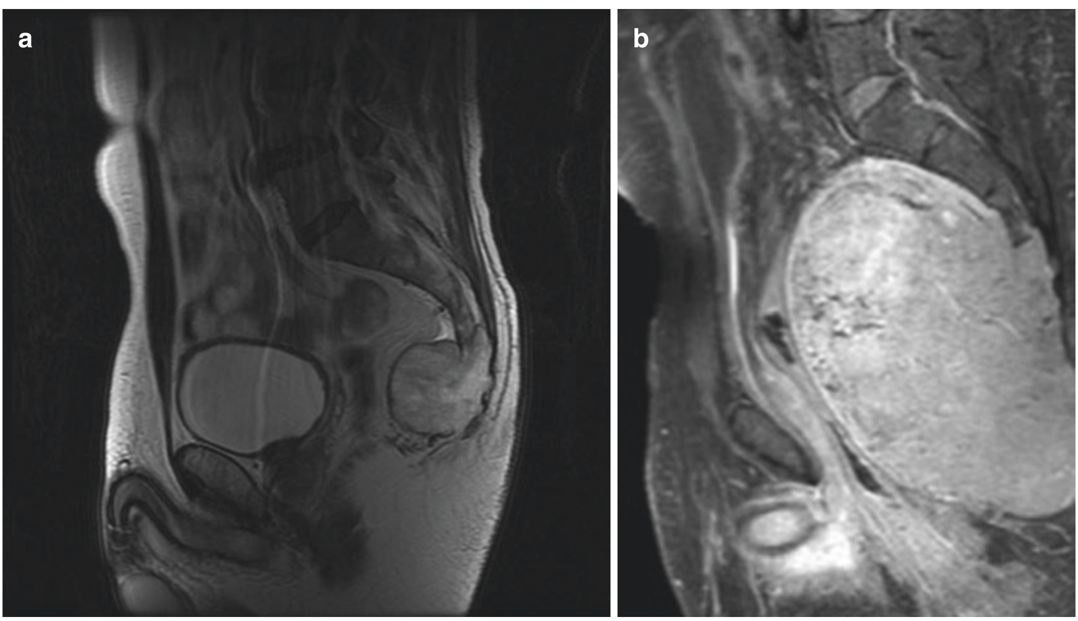

Fig. 36.3 (**a**) Sagittal view of a sacral chordoma. (**b**) Sagittal view of large sacral chordoma. (Couresy of Dr. Laurence Sands)

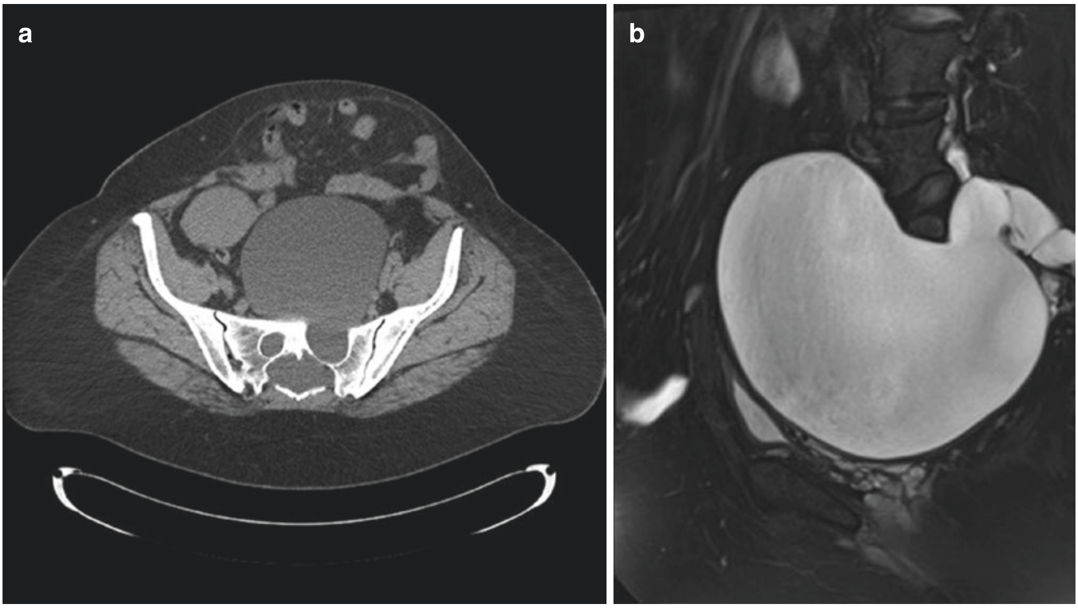

Fig. 36.4 (**a**) Axial and (**b**) sagittal view of an anterior meningocele. (Courtesy of Dr. Laurence Sands)

G. Neurogenic
   Neurogenic lesions include neurofibromas, neurolemmomas, ependymomas, ganglioneuromas, and neurofibrosarcomas (Fig. 36.5). These lesions account for approximately 10% of all retrorectal tumors. These may be benign or malignant, however, their behavior is difficult to preoperatively determine. The majority of these patients will present with neurologic complaints as a presenting symptom.
H. Osseous
   Osseous lesions can be either benign or malignant and include osteoma, osteogenic sarcoma, sacral bone cysts, Ewing tumors, giant cell tumors or chondromyxosarcomas (Fig. 36.6). Osseous tumors tend to be locally aggressive and have metastatic potential. Resection of these lesions is indicated with a radial excision of all involved structures, usually done in conjunction with an orthopedic surgeon. Aggressive tumors such as Ewing or osteogenic sarcoma may benefit from neoadjuvant radiation and chemotherapy.

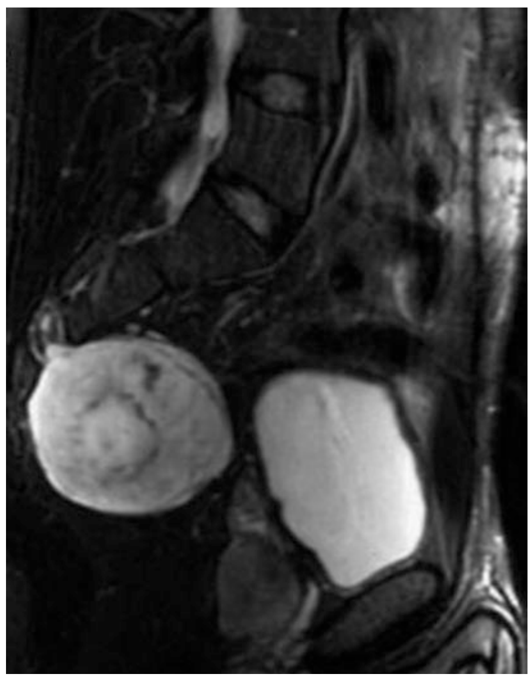

Fig. 36.5 Neurogenic retrorectal tumor

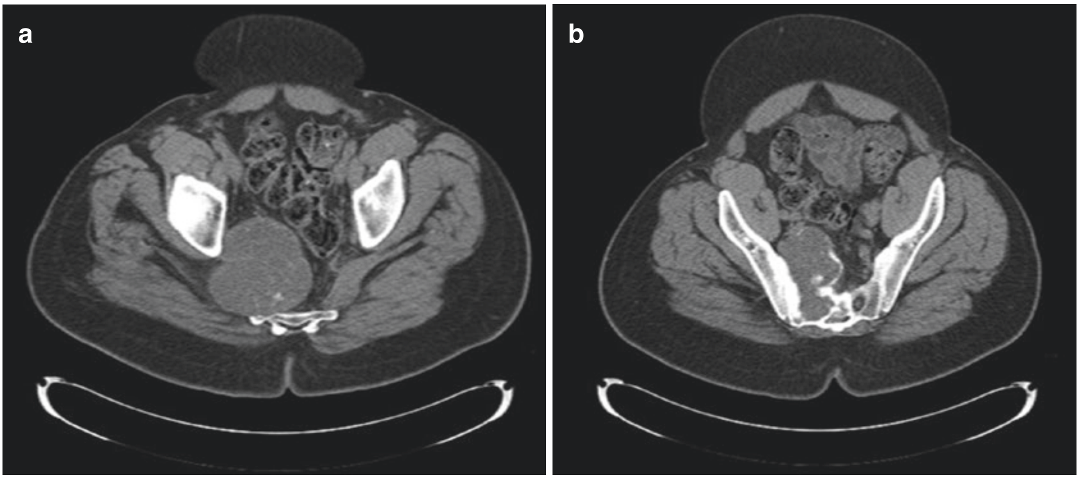

Fig. 36.6 Two views of an invasive chondrosarcoma

I. Miscellaneous
This diverse group of pathologic diagnoses may include any inflammatory masses from chronic infection or anastomotic leak from the rectum as well as metastatic disease, lymphomas, lymphangiomas, desmoid tumors, leiomyomas, fibrosarcomas or endotheliomas. These tumors can occur anywhere within the retroperitoneum. Endometriomas can also be found in the retrorectal space. Metastatic disease in this space is most commonly from a rectal cancer primary. Gastrointestinal stromal tumors (GIST) can also arise in the presacral space.

Treatment

J. Prone/Posterior Approach
Surgical excision of retrorectal tumors is indicated for any type of tumor. These masses have a tendency to harbor malignancy or undergo malignant degeneration. Benign congenital cysts may become infected and lead to problems with abscesses and fistula formation, which adds morbidity to any planned surgical procedure. Excision of these masses in women of child bearing age is also particularly important, since these women may have complications during childbirth secondary to vaginal obstruction.

The prone/posterior (Kraske) approach is appropriate for tumors that are below the level of S4 (Fig. 36.7). Any tumor that extends proximally to this landmark may not be surgically accessible through the posterior approach. This approach is acceptable for small, benign tumors. Any tumor that has concern for invasion into surrounding structures, lateral sidewall or neurovascular structures should not be approached through a posterior approach alone. Technically this operation is performed with the patient in prone jack-knife position with a transverse incision overlying the coccyx or a vertical incision from the anal verge to the coccyx. Once the subcutaneous tissue is entered, the anococcygeal ligament and levator should be incised to gain access to the coccyx and retrorectal space. Care is taken to avoid any injury to the muscular wall of the rectum, which may increase postoperative infection rates. The sacral nerves are also well visualized in this technique. The tumor is then able to be exposed and dissected free from the retrorectal space. A finger within the rectum may help to identify the wall to prevent injury rectal injury or to facilitate recognition of such injury. A drain should be left post operatively, since there is usually a large space left by the tumor.

K. Combined Abdominal/Posterior
The combined posterior/abdominal approach is utilized for patients with tumors that

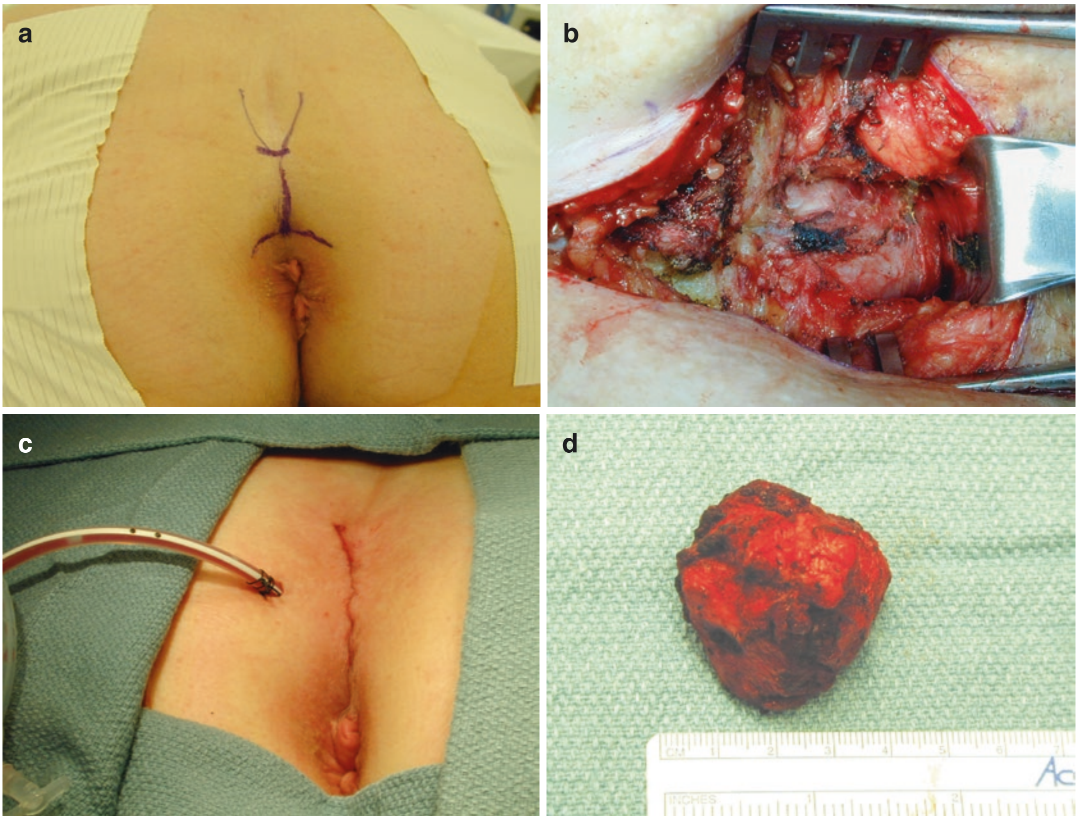

Fig. 36.7 (**a**) Preoperative marking for a posterior approach (**b**) intraoperative picture of resection of tumor. (**c**) Closure of the wound with drain (**d**) picture of the resected cyst. (Courtesy of Dr. Eric G. Weiss)

extend above S3, usually with concern for invasion into the sacrum or involvement of other pelvic structures such as iliac vessels, ureters, sacral nerve roots or rectum. This approach is useful to be able to correctly identify and control structures prior to resection of the tumor. Vascular control is imperative if the tumor is invasive into the vascular structures. Ureteric stents may be utilized to identify the ureters. The tumor can be approached from the abdomen and continued into the perineum, when no more dissection can be done from above. This approach is particularly useful for anterior sacral meningocele, where the sac can be dissected from the perineum and ligated from within the abdomen. These tumors require a multidisciplinary team of surgeons to resect the tumor including colorectal, orthopedic, plastic and neurosurgeons.

The abdominal approach is initiated by mobilizing the left colon and rectum. The dissection is similar to a total mesorectal excision, and the retrorectal space is accessed from the sacral promontory. Care is taken to dissect the rectum free from the tumor. If the tumor is densely adherent to the rectum or invading into the rectum, a proctectomy should be performed. In the majority of cases an anastomosis can be safely performed, either as a stapled or a hand-sewn anastomosis. However, extensive soft tissue involvement of the perineum may mandate abdominoperineal resection.

If a malignant tumor invades the sacrum, a partial sacrectomy should be performed. Preoperative determination of the level of resection is important. The abdominal dissection is important to identify any nerves, ureter and vessels to protect them during resection.

Exposure from above and below is important when performing a partial or hemisacrectomy. Sacral resections below S3 are tolerated fairly well in terms of function. Resections above S3, including S2/1 will be very morbid for the patient. Sequelae include both fecal and urinary incontinence and dysfunction for patients with a unilateral resection. Bilateral resection will guarantee abnormal function. There is also considerable bony reconstruction involved to ensure lumbar-sacral stabilization.

Extensive resections may result in large soft tissue defects, for which flap closure may be required. For smaller defects, a V-Y flap or gracilis flap may be used to fill soft tissue defects. For large defects, a transversus abdominis myocutaneous flap may be required.

L. Abdominal
The abdominal approach is appropriate for tumors that lie above S3. The characteristics of the tumor, including invasion into the surrounding structures should be evaluated with preoperative imaging. This approach is appropriate for tumors that do not extent into the sacrum, which would be better served with a combined approach. Preoperative placement of ureteric stents may also be beneficial to identify the ureters, if the dissection plane is not clear during resection. Anterior resections may be laparoscopically performed.

M. Adjuvant/Neoadjuvant Chemo and Radiation
Treatment of retrorectal tumors is primarily with surgery. Locally advanced tumors that are not resectable may be treated with palliative chemotherapy or radiation, however results are poor. Treatment is based on the tissue type and characteristics of the tumor. Chordomas, for instance, are radioresistant. For large GIST tumors in the retrorectal space, neoadjuvant imatinib can be considered prior to surgical resection.

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Rectal Cancer: Local Therapy

37

David M. Lisle and Dana R. Sands

Refer to Algorithm in Fig. 37.1

A. *Morphology.* The traditional characteristics of tumors considered to be amenable to local excision include: size less than 3 cm, less than 1/3 circumference of the rectal wall, mobile, low lying and those not situated on the anterior wall. These stipulations are not necessarily mandated when considering local excision with transanal endoscopic techniques. Certainly, fixation of the tumor would suggest locally advanced disease and would be a contraindication. Anterior lesions should be approached with caution for the urinary and gynecologic structures but are not contraindicated for local excision. Size stipulation and degree of circumferential involvement are less important considerations than is proper staging and surgeon experience and skills to manage larger lesions. The proximal extent of resection has been greatly extended with transanal endoscopic techniques. Peritoneal entry is not uncommon and can be adequately managed in experienced hands.

B. Local excision does not involve removal of rectal lymph nodes. The goal is, therefore, to identify those early cancers that are confined to the bowel wall without lymph node metastasis. Preoperative staging is vital to decision making as a high suspicion of lymph node metastasis preoperatively would make local excision an inadequate oncologic operation. The radiologic staging of rectal cancer has traditionally employed endorectal ultrasound for locoregional disease assessment. The depth of invasion had been reported with 65–90% accuracy while the nodal involvement accuracy ranges from 60–80%. Rectal MRI has evolved over the last decade to provide valuable information for physicians treating patients with rectal cancer. High resolution MRI is capable of differentiating the degree of rectal wall invasion. Early rectal cancer and degree of submucosal invasion are still a challenge to accurately diagnose with any radiographic modality. Nodal involvement with specific criteria such as heterogeneous signal intensity and irregular capsular borders are accurate predictors of metastatic spread. Large vein extramural vascular invasion and mucin deposits are also assessed with high resolution MRI and are considered poor prognostic indicators. Depth of invasion of the rectal wall is an important predictor of lymph node metastasis (Table 37.1). Therefore, only T1 and some T2 cancers with no suspicious lymph nodes on preoperative MRI or endoscopic ultrasound should be considered for local excision.

C. Certain histologic features of rectal cancer are also associated with higher risk of lymph

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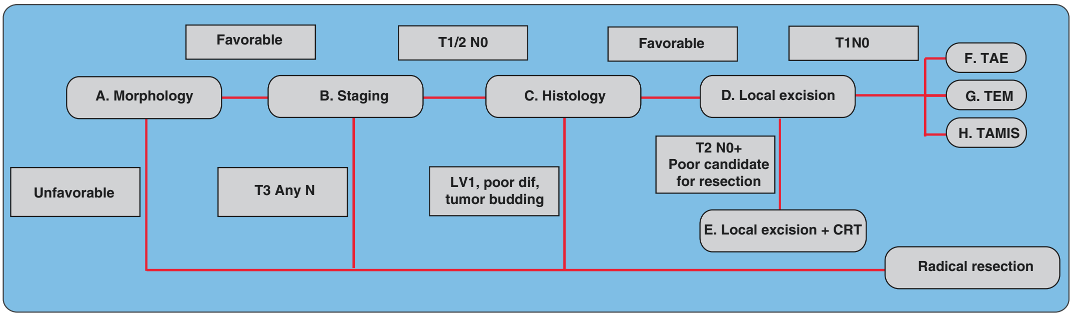

Fig. 37.1 Algorithm for local therapy for rectal cancer. *TAE* transanal excision, *TEM* transanal endoscopic microsurgery, *TAMIS* transanal minimally invasive surgery, *CRT* chemoradiation therapy

Table 37.1 The incidence of lymph node metastasis based on T-stage of rectal cancer

T stage	Incidence (%)
1	0–12
2	22–28
3	36
4	53

node metastasis. In patients with lymphovascular invasion (LVI) the incidence of lymph node metastasis is 31% vs 17% in those patients without lymphovascular invasion. In addition poorly differentiated tumors have a higher rate of lymph node metastasis at 50% compared to moderate and well differentiated cancers (30% and 13% respectively). Lastly, the presence of tumor budding has been shown to be a predictor of lymph node metastasis with an odds ratio of 5.1–5.8. Based on these data only those rectal cancers that are well differentiated with no tumor budding or lymphovascular invasion should be considered for local excision. In a recent meta-analysis of histopathological predictors of lymph node invasion, 30,000 patients were evaluated for 12 pathologic risk factors. Statistical significance was reached for tumor stage, differentiation, budding, lymphovascular invasion and differentiation at the invasive front. It has been shown as well that the combination of poor differentiation and vascular invasion can have as high as 65% incidence of lymph node invasion for T1 lesions. Careful consideration of pathologic risk factors is a must prior to local excision.

D. Those rectal cancers that meet the criteria from [A], [B], and [C] are candidates for local excision. For all methods of local excision the patient should receive full mechanical cathartic bowel prep. The patient should be positioned according to the location of the tumor so that it is in the inferior aspect of the working field. For example the prone jackknife position is best for anterior tumors, whereas lithotomy position is preferred for posterior tumors lithotomy and for decubitus contralateral position for lateral tumors (Fig. 37.2). It is necessary to perform a full thickness excision for rectal cancer. The author recommends closure of all defects following excision. It is not necessary to close those defects below the peritoneal reflection. However, it is good practice especially when doing TEM and TAMIS to perform closure of the defect to ensure that this skill is perfected in the event of peritoneal entry. The surgeon should also consider whether or not the patient has received preoperative radiation as it may impede wound healing. In this case the surgeon may opt not to close a rectal defect below the peritoneal reflection.

E. The risk of lymph node metastasis is higher in patients with T2 rectal cancer compared to T1 cancers. Several studies have investigated the effectiveness of neoadjuvant radiation in addition to local excision for T2 cancers. The ACOSOG Z6041 trial evaluated patients with T2N0 disease treated with local excision and radiation therapy. Recurrence was noted in 7 of 84 patients (2 local and 5 distant) after an average follow up of 4.2 years with overall survival of 96% at 3 years. Adequate evi-

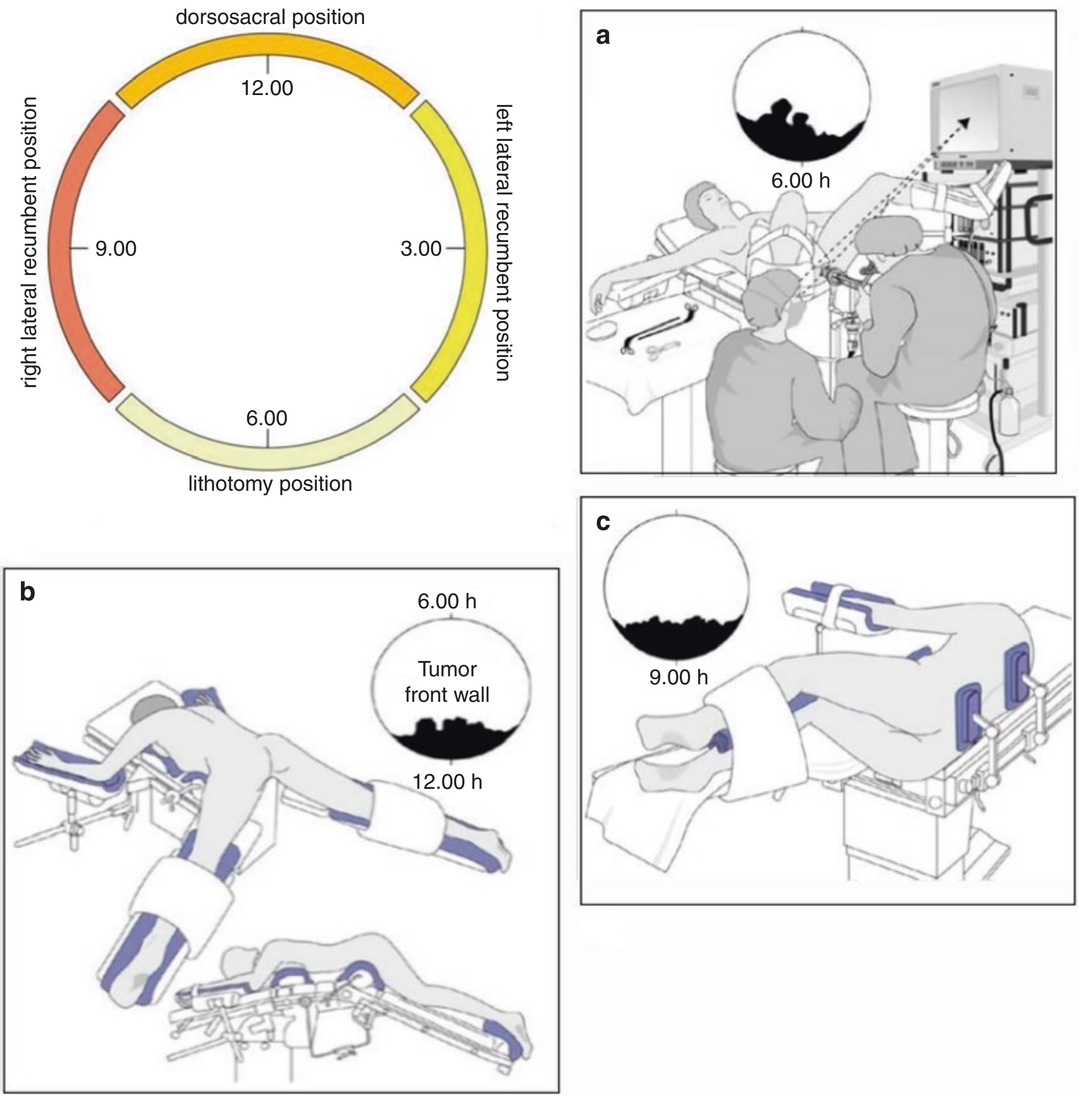

Fig. 37.2 The patient should be positioned according to the location of the tumor so that it is in the inferior aspect of the working field. (**a**) For posterior tumors lithotomy; (**b**) For anterior tumors, prone jack-knife; (**c**) For lateral tumors decubitus position

dence comparing neoadjuvant radiation plus local excision to radical resection is still lacking and traditional resection remains the gold standard. However, local excision is an option for those patients who are poor candidates for an extensive operation and those who refuse radical surgery. Local excision in patients with more advanced disease following radiation therapy should be limited to those who are not candidates for radical resection or those in the setting of a formal trial.

Local Excision Techniques (Refer to Table 37.2)

Local excision can be performed either in the standard transanal fashion or through one of the transanal endoscopic surgery (TES) platforms: Transanal endoscopic microsurgery (TEM), transanal endoscopic operations (TEO), or transanal minimally invasive surgery (TAMIS).

F. **Transanal excision (TAE)**: An anal retractor is used to obtain adequate visualization of the tumor. If necessary sutures can be placed above the proximal tumor margin to prolapse the tumor and improve visualization. Next, the line of dissection is marked by circumferentially scoring the rectal mucosa with electrocautery for 1–2 cm around the tumor margin. A full thickness excision down to the perirectal fat is then carried out using electrocautery along the previously marked line of dissection. The defect is then transversely closed using interrupted absorbable suture. For anterior cancers, it is important to be mindful of the vagina in females. A bimanual exam should be intermittently performed throughout the procedure to gauge thickness and prevent dissection into the vaginal wall. This technique is best for small tumors at the level of the dentate line.

Table 37.2 Anatomical Considerations in selecting method of local excision

Technique	Utilization
TAE (Transanal excision) [F]	Small distal rectal cancer [I]
TEM (Transanal endoscopic microsurgery) [G]	Larger cancers above the first rectal valve [J]
TEM or TAMIS (transanal minimally invasive surgery) [H]	Smaller cancers at or below the first rectal valve [K]

G. **Transanal endoscopic surgery (TES)**: Transanal endoscopic surgery (TES) is a generic term used to include all of the various transanal endoscopic surgical platforms and techniques. The original modality, transanal endoscopic microsurgery (TEM) utilizes an operating platform containing a rigid proctoscope and endoluminal insufflation to provide stable pneumodistension of the rectum for improved visualization. The proctoscope is 4 cm in diameter and is available in both 12 and 20 cm lengths depending on the location of the rectal tumor. A laparoscopic camera is inserted through the proctoscope to display the image on a screen. Alternatively, the surgeon can look through the stereoscopic eye piece attached to the platform which provides a 3D image through the proctoscope. Three 5 mm working ports exist on the platform where angulated instruments similar to laparoscopic instruments can be introduced for the dissection (Fig. 37.3). Patient positioning is important in TEM surgery as the optics are

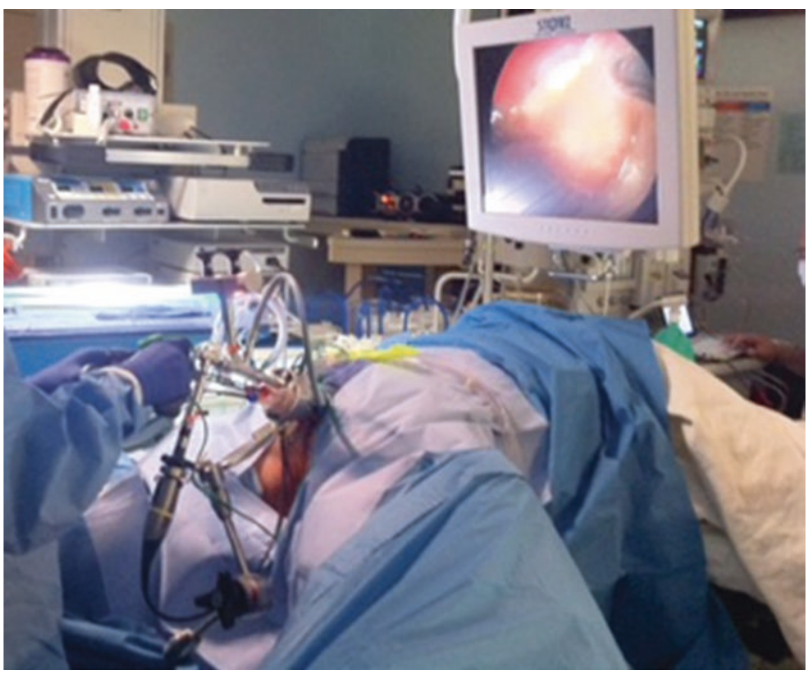

Fig. 37.3 Three 5 mm working ports exist on the platform where angulated instruments similar to laparoscopic instruments can be introduced for the dissection

fixed with the platform. The patient must be positioned so that the rectal mass is in the inferior aspect of the working field. Therefore, patients with anterior rectal masses are placed in prone jack-knife position and patients with posterior masses are placed in lithotomy. Left or right lateral decubitus positioning is used for lateral lesions. The anus is gradually dilated and the proctoscope is introduced into the rectum. Once the mass has been identified and centered in the field of vision, the platform is fixed in place to the OR table using the multijointed Martin arm (Medline Industries Inc) (Fig. 37.4). Cautery is then attached to one of the 5 mm instruments (needle tip, hook or spatula) and a line of dissection is marked 1 cm from the tumor border circumferentially by scoring the mucosa. A grasper can be inserted in the other port site to help retract the tumor towards the field of vision and improve visualization. A full thickness excision down to the perirectal fat is then carried out using the previously marked line of dissection as a guide. The tumor is removed by disconnecting the platform faceplate and is oriented and sent to pathology. Next, the defect should be closed transversely. For a large defect a suture can be placed in the middle of the wound to reapproximate the edges and remove tension (Fig. 37.5). The remaining defect can then be closed with 2 running sutures. A clip applier is utilized and obviates the need for knot tying in a confined space. Like TEM, transanal endoscopic operating also utilizes a rigid platform.

H. **Transanal Minimally Invasive Surgery (TAMIS)**: Similar in theory to TEM surgery, TAMIS also utilizes endoluminal insufflation to distend the rectum and improve visu-

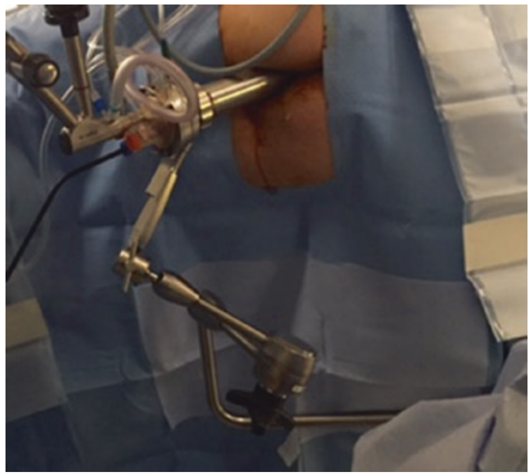

Fig. 37.4 Once the mass has been identified and centered in the field of vision, the platform is fixed in place to the operating room table using the multijointed Martin arm (Medline Industries Inc. Medford, NJ)

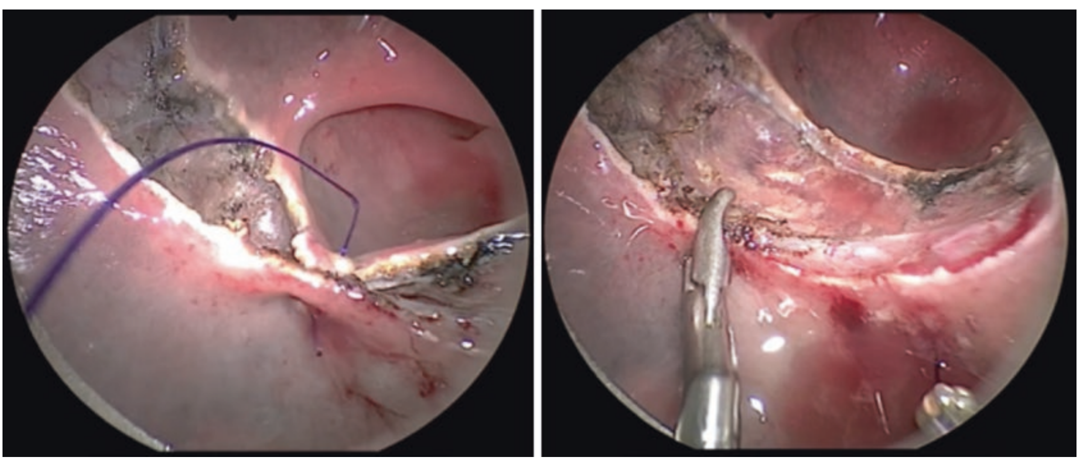

Fig. 37.5 For a large defect, a suture can be placed in the middle of the wound to reapproximate the edges and remove tension

Fig. 37.6 Transanal Minimally Invasive Surgery (TAMIS). Instead of a platform containing a rigid proctoscope, a small GelPort (Applied Medical. Rancho Santa Margarita, CA) is inserted into the anus

alization. Instead of a platform containing a rigid proctoscope, a small GelPort (Applied Medical) is inserted into the anus (Fig. 37.6), 3 5 mm ports are placed through the gel port in a triangular manor and insufflation attached to one of the ports to distend the rectum. Newer technology is available to provide balanced insufflation (Air Seal) and smoke evacuation. When working in small spaces even minimal amount of suctioning can deflate the lumen and obscure visualization. The ability to provide balanced insufflation and smoke evacuation while performing TAMIS has been a significant advance over the use of standard laparoscopic insufflators. A 5 or 10 mm 30° laparoscope is inserted through one of the ports and held by an assistant. Laparoscopic instruments are placed through the other two working ports for dissection. Similar to TEM, the location of the mass determines patient positioning with TAMIS. The patient should be positioned so that the mass in the inferior location. However, unlike TEM, the laparoscope is not fixed and can be moved freely. It is therefore, technically possible, although potentially more difficult, to resect a mass in any location with the TAMIS platform while keeping the patient in the lithotomy position. This may be advantageous for patients whose body habitus prohibits prone or lithotomy positioning. The steps of TAMIS are similar to TEM and involve full thickness excision of the tumor with a 1 cm margin similar to that method described above.

Anatomical Considerations in Selecting Method of Local Excision (Refer to Table 37.2)

I. Transanal excision is limited to distal rectal cancers as proximal and mid rectal cancers are difficult to visualize through an open transanal technique even with an anal retractor device. Some surgeons argue that even distal rectal cancers are difficult to visualize and perform sound oncologic local resection on especially in patients with difficult body habitus. Several studies have shown higher recurrence rates with transanal excision compared to radical resection (12.5% vs 6.9%). However, 5 year overall survival is similar (77.4% vs 81.7%).

J. TEM is the preferred modality for cancers that are larger and those above the first rectal valve. The TEM platform is able to reach the more proximal rectum and distal sigmoid compared to the TAMIS platform due to the availability of both a 12 and 20 cm proctoscope. The benefit of the rigid proctoscope is not only in proximal reach, it also serves as a retractor of the first and second rectal valves which can hinder visualization when using a soft platform. This feature can prove invaluable in the excision of proximal lesions and perhaps more importantly, obtaining adequate closure of the defect in cases of peritoneal entry. In addition it has the advantage of being single operator if there is no assistant available to hold the camera which is necessary for TAMIS. A Meta analysis comparing TEM to radical excision for T1N0 rectal cancers showed equivalent 5 year overall survival.

K. TEM or TAMIS is often the preferred platform for small early rectal cancers below the first rectal valve. The TEM platform has the option of a straight edge proctoscope rather than the beveled edge which can interfere with the seal at the level of the anus in low

lesions. The TAMIS platform is more flexible, allowing access to lesions which may be located in intermediate locations on the rectal wall, but may overlap the most distal rectal lesions potentially covering them and obscuring their view. In this case, the dissection may be initiated with traditional transanal approach and eversion of the anus. Once the distal tumor has been mobilized enough to allow placement of the TAMIS or straight edge TEM proctoscope advanced endoscopic assistance can be utilized for the more proximal dissection.

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38 Rectal Conditions: Rectal Cancer—Proctectomy

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Refer to Algorithm in Fig. 38.1

A. In the current climate of evolving oncologic therapies, increasing evidence has shown that a multidisciplinary approach, with surgical resection at the forefront of curative treatment, improves oncologic, clinical decision-making, and functional outcomes for patients with rectal cancer. For this chapter, we will be focusing on the surgical therapy for resectable rectal cancer and reserve discussion of treatment for unresectable disease and disease amenable to local therapies for elsewhere in this text. Quality oncologic resection requires experience and a deep understanding of the pelvic anatomy in order to yield the best probability of good oncologic and functional outcomes.

B. In order to determine the most appropriate treatment options for the patient, a preoperative evaluation must include not only staging of the cancer according to the TNM classification, but also evaluation of the location of the tumor relative to the sphincter complex, involvement of any adjacent structures, and proximity or involvement of the circumferential resection margin (CRM).

- Thorough physical examination including detailed digital rectal examination can help determine location of the tumor and proximity to anal sphincters, firmness, ulceration, and fixation.
- Carcinoembryonic Antigen (CEA).
- Colonoscopy, if not already performed, to exclude proximal synchronous tumor(s), to obtain histology, and location of tumor including distance from anal verge or dentate line, as well as circumferential location as it relates to surrounding structures. A rigid proctoscope is often preferred in this setting to more accurately assess tumor distance from the verge and distinguish among upper, mid, and lower rectal locations.
- Endorectal Ultrasound (ERUS) or Magnetic Resonance Imaging (MRI) for local-regional staging. ERUS may have advantage in evaluating depth of involvement for early stage tumors, whereas MRI is the only modality that can assess circumferential margin and is the most commonly used method presently. MRI is the accepted standard by the Commission on Cancer (CoC). National Accreditation Program for Rectal Cancer (NAPRC).
- Computed Tomography (CT) of the chest, abdomen, and pelvis to evaluate for distant metastasis.

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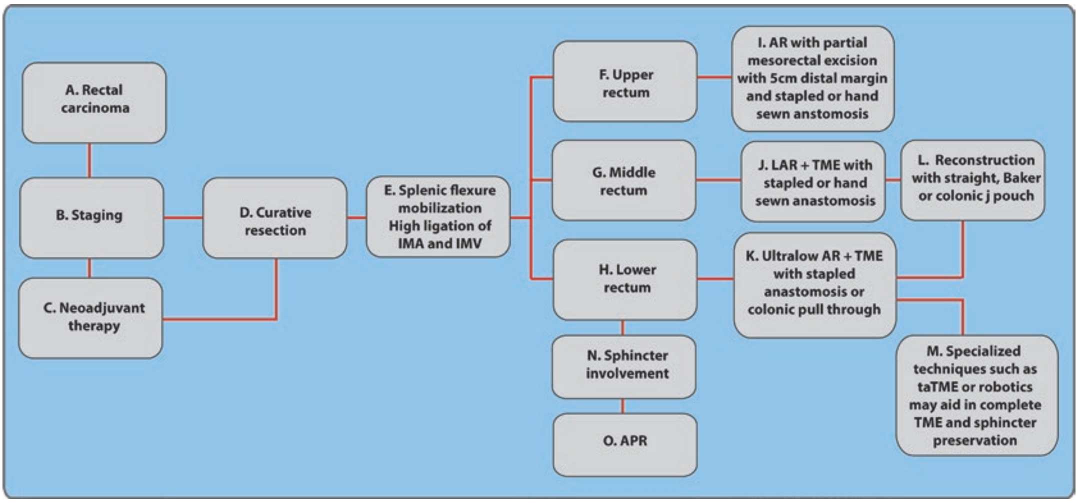

Fig. 38.1 Algorithm for treatment of rectal cancer–proctectomy. *IMA* inferior mesenteric artery, *IMV* inferior mesenteric vein, *APR* abdominal perineal resection, *AR* anterior resection, *LAR* low anterior resection, *TME* total mesorectal excision, *taTME* transanal total mesorectal excision

C. Neoadjuvant chemoradiotherapy for locally advanced rectal cancer (cT3-4, cN0 or any cT, cN1-2) reduces the risk for local recurrence when compared to surgery alone in several landmark studies. Chemoradiation delivered in the neoadjuvant setting is associated with a lower rate of recurrence and higher treatment completion rates compared to adjuvant chemoradiation. Short-course radiation can also be delivered in neoadjuvant setting and shown to significantly reduce local recurrence. Neoadjuvant chemoradiotherapy may also be considered for those patients with low rectal tumors where sphincter-preserving surgery would not yield adequate results without reduction of the tumor burden. Upper rectal lesions (above the peritoneal reflection) are more controversial, and in many cases do not require neoadjuvant therapy and can be resected primarily.

D. The anatomy of the rectum can be quite variable from patient-to-patient and requires experience and reliance on key anatomical constants when operating in a radiated and occasional difficult anatomical of the pelvis. The location of the rectal tumor is often measured as the distance from the anal verge or the dentate line, and the height of the rectum varies between 12 and 15 cm by rigid proctoscopy, depending on the type of measurement and size of the patient. Some surgeons will use the relationship of the tumor to the rectal valves as a reference point for height of the tumor (low, middle, and upper rectum).

The superior aspect of the rectum is identified as the colon passes over the sacral promontory into the pelvis and the taeniae coalesce to form a complete layer of longitudinal muscle. The anatomy which comprises the mesorectal excision can be separated similarly to how they are encountered surgically, the anterior, posterior, and deep anatomy. From superior to inferior the anterior excision is comprised of:

- The intraperitoneal anterior wall of the rectum.
- The peritoneal reflection.
- Denonvilliers' fascia behind the seminal vesicles and fusing with the fascia on the back of the prostate in males.

Posteriorly the mesorectum is largely comprised of a bilobed lipomatous like structure that lies anterior to the sacrum and enveloped by the investing visceral fascia of the hindgut. Waldeyer's fascia invests

the front of the sacrum and provides some protection from the venous plexus and autonomic nervous plexus of the pelvis. Between the investing fascia of the mesorectum and the investing fascia of the sacrum posteriorly is an avascular plane of dissection that guides the surgeon to a complete mesorectal excision, the so-called "Holy Plane" of dissection. Distally the mesorectum narrows or tapers into a "waist" as the lipomatous lymphatic and vascular supply tapers and the muscular wall of the rectum becomes the internal anal sphincter as it inserts into the pelvic floor.

Essential to functional outcomes following a TME is an understanding and awareness of the sympathetic and parasympathetic fibers that supply the rectum and genitourinary tract. The sympathetic or superior hypogastric plexus arises from T12-L2 and passes anteriorly over the aortic bifurcation and sacral promontory as it divides laterally into the right and left hypogastric nerves. Damage to these nerves can result in urinary incontinence and retrograde ejaculation. As the superior hypogastric plexus travels inferior and lateral in the pelvis, posterior to the mesorectum it joins the pelvic splanchnic nerves, or nervi erigentes, to form the inferior hypogastric plexus. Injury to the parasympathetic nerves when dissecting out the mesorectum can lead to erectile dysfunction and bladder dysfunction.

As the TME dissection commences, the avascular presacral plane will act as a guide for the rest of the abdominal approach to the dissection. The plane can reliably be found by retracting the rectum up and out of the pelvis and scoring the peritoneum over the sacral promontory from the right side of the patient. Care should be taken to avoid the sympathetic trunks at this location. Once entered, this plane can be followed both distally and laterally to completely encompass the visceral fascia of the mesorectum.

E. Consistent with oncologic principles of surgery, the mesentery of the colon and rectum should be taken *en bloc* with the specimen. For rectal cancer, ligation proximal to the superior rectal artery (low tie) has similar survival outcomes to ligation of the IMA proximal to the left colic artery (high tie). However, a high ligation is often necessary in order to provide adequate length for a tension-free anastomosis and should be performed when patients have suspicious lymph node involvement proximal to the superior rectal artery. Additionally, a high ligation of the inferior mesenteric vein is advocated both for lymph node yield and adequate mobilization for tension-free anastomosis. Routine high ligation of the vessels and complete splenic flexure mobilization are can be essential maneuvers to ensuring a tension-free anastomosis. In those patients with a redundant and floppy colon who are undergoing a more proximal anastomosis or an abdominal perineal resection (APR), a splenic flexure mobilization may not be required.
F. The location of rectal tumors is often described in reference to the upper (11–15 cm from anal verge), middle (7–11 cm from anal verge), or lower third (anorectal ring to 7 cm from anal verge) of the rectum. The anatomical association to this reference is that the upper third of the rectum is intraperitoneal and covered by peritoneum anteriorly and laterally. The middle rectum is anteriorly covered by peritoneum while the lower third is devoid of peritoneum and is entirely extraperitoneal.
G. Tumors of the middle and lower third of the rectum should undergo a complete TME including anterior dissection through Denonvilliers' fascia. This will allow for complete excision of lymphatic drainage and minimize risk of local recurrence.
H. Secondary to several anatomic constraints, tumors of the lower rectum often present the greatest challenge to successful outcomes. Proximity to the pelvic floor and sphincter complex may make satisfactory functional

outcomes unobtainable and complete excision of the tumor may require an abdominal-perineal resection (APR) for adequate oncologic and functional outcomes. Additionally, the natural mesorectal plane narrows deep in the pelvis making the circumferential margin at higher risk of being threatened. Extra-organ involvement is also more likely with tumors in this location given the proximity of the seminal vesicles, prostate, and vagina.

I. Much controversy exists over the most appropriate distal margin of resection. Distal lymphatic or intramural spread of the tumor presents the potential for a positive distal margin despite a clear gross margin intraluminally. However, a distal mesorectal margin of 5 cm for an anterior resection has been accepted for rectal cancer of the upper third of the rectum, but should be weighed against other clinical and pathologic features of the tumor. A complete posterior and lateral dissection should be performed during this operation while maintaining the lateral stalks prior to determining where to divide the distal margin.

J. While concern over technical difficulties and risks for morbidity following increased rates of anastomotic leaks and pelvic sepsis are present, middle rectal tumors should undergo a low anterior resection with total mesorectal excision with a stapled or hand-sewn anastomosis.

K. When possible, a sphincter-sparing operation should be the operation of choice for rectal cancer, including low rectal tumors where sphincter preservation and reasonable functional outcomes are possible without increasing the risk of unfavorable oncologic outcomes. Whereas 5 cm of distal margin is ideally accepted for more proximal tumors, various studies have found that margins of 2 cm or less have resulted in similar oncologic outcomes. When compared to the difference in quality of life between an APR and a sphincter-sparing operation, a low colorectal or even coloanal anastomosis is often preferred for patients with good preoperative sphincter function.

Once the oncologic concerns of proper resection margins have been met and anal sphincter function accounted for, the greatest concern in the postoperative period is the risk of anastomotic leak and pelvic sepsis. The risk of anastomotic leak in a low pelvic anastomosis can be up to 3–32% depending on multiple risk factors including tumor height, receipt of neoadjuvant therapy, and comorbid conditions. Technical factors increasing the risk of anastomotic leak include relative ischemia and tension on the anastomosis. Several meta-analyses have been published evaluating the role of diverting ileostomy for low anterior resections (LAR) and confer that a diverting stoma reduces the risk of both anastomotic leak and the need for reoperation by approximately 60–70%. For this reason the authors advocate routine diverting loop ileostomy for low and ultra-low anterior resections in addition to leak testing all colorectal and coloanal anastomoses.

L. Reconstructive options following low and ultra-low anterior resection include a straight anastomosis, colonic J-pouch, coloplasty, or a Baker-type side-to-end anastomosis. Several factors should be taken into account when deciding on restorative technique for optimizing function of the postoperative neo-rectum. With the loss of the rectum as a reservoir, and disturbance of the anorectal reflex with low pelvic dissections patients can experience frequency, urgency, soiling, and incomplete evacuation, a constellation of symptoms known as the LAR syndrome. The risk of these symptoms are increased with lower anastomoses and with decreased reservoir compliance. Large systematic reviews have shown that for the first 1–2 postoperative years the functional outcomes for patients are improved following colonic J-pouch reconstruction compared to straight coloanal or colorectal anastomosis. For this reason, when colonic length is adequate, and the pelvic volume can accommodate a larger reconstructed reservoir, the authors prefer where feasible, a colonic J-pouch reconstruction or side-to-end as opposed to a

straight anastomosis for low and ultra-low sphincter-sparing operations. Prior to advancing the circular stapler or performing an anastomosis, rectal washout with a tumoricidal agent may reduce any theoretical risk of exfoliating intraluminal tumor cells, although data has not consistently shown benefit to this maneuver.

M. Minimally invasive techniques in colorectal surgery have repeatedly shown benefits in outcomes of early postoperative recovery; however, studies comparing laparoscopic to open surgery have less consistency and yield conflicting results for short- and long-term oncologic outcomes. In the MRC CLASICC trial, 794 patients in the UK were randomized 2:1 to laparoscopic or open resection for rectal cancer. The laparoscopic group had a higher rate of positive CRM; however this did not translate into long-term differences in outcomes, with the laparoscopic group have equivalent overall survival, disease-free survival, and local recurrence rates. The COLOR II Trial was another randomized controlled trial comparing the oncologic outcomes of 1044 patients who underwent laparoscopic or open resection for rectal cancer. In this large European study, there was no difference in the 3-year locoregional recurrence rate, disease free survival, or overall survival between the laparoscopic and open groups. The ACOSOG Z6051 Trial was a multicenter randomized controlled trial in the U.S. and Canada involving 486 patients with Stage II or III rectal cancer who underwent neoadjuvant therapy. In this study laparoscopic approach was compared to open approach in a non-inferiority analysis for pathologic outcomes clear distal and circumferential margins and well as the completeness of the mesorectal excision. For the authors, the preferred technique remains to be a minimally invasive approach. Challenges still exist for treating low rectal tumors, particularly when operating in a narrow pelvis or on patients with increased visceral adiposity. Newer techniques that have growing popularity are the use of robotic surgery and combined transanal and transabdominal approach. Advocates for robotic surgery suggest that articulating instruments and improved visualization aid in improved dissection in the difficult pelvis and low-lying tumors. Proponents of transanal total mesorectal excision also advocate that this technique adds benefit to improved oncologic specimens primarily for low and ultra-low tumors, possibly increasing the feasibility of sphincter sparing operations for patients with ultra-low cancers, although data on the long-term value of these techniques are still being formulated.

N. Sphincter preservation is not advisable for those patients with poor sphincter control or who have low tumors invading the levators or anal sphincters following neoadjuvant treatment. These patients should undergo *en bloc* resection of the anus, rectum, and sigmoid colon with permanent descending colostomy possibly as an extralevator APR.

O. While APR has long been the gold standard operation for patients with low rectal cancer, recent evidence has shown that the improved oncologic outcomes associated with TME and neoadjuvant chemoradiation have not been routinely replicated in patients undergoing APR. Keeping in mind that these tumors have a higher propensity for local spread and invasion into adjacent tissues given the lack of a mesorectum, studies have shown positive circumferential resection margin (CRM) rates in the 30% range for APR compared to 11% for LAR. Additionally, APR has a higher rate of incomplete dissection and a perforation rate nearly 14% compared to 2.5% for LAR. Some surgeons have advocated for extralevator APR to combat the high risk for positive margins or incomplete resections. In this approach the perineal dissection is started with a wide cylindrical incision and carried through the ischiorectal fat and the levator ani divided at the attachment to the sidewall, therefore eliminating the “waist” associated with the standard APR specimen and decreasing the risk of a positive CRM. The downside to this technique,

however, is the resultant large perineal defect which often requires a flap for closure and has a higher rate of wound complications.

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39 Rectal Conditions: Rectal Cancer—Adjuvant and Neoadjuvant Therapy

Terry Zwiep, Julie Ann Van Koughnett, and Patrick H. D. Colquhoun

Refer to Algorithm in Fig. 39.1

A. Introduction
   The American Cancer Society predicted an incidence of rectal cancer of approximately 43,340 patients in United States alone in 2020. Surgical resection remains the mainstay of curative therapy for rectal cancer in most patients; however, the treatment algorithms for rectal cancer are complex when the roles of neoadjuvant and adjuvant treatments are considered. The appropriate use of neoadjuvant and adjuvant therapies requires proper workup and staging. A multidisciplinary approach is critical to account for these treatment nuances and ensure optimal patient outcomes.

B. Staging
   Staging of rectal cancer is multifactorial and utilizes a combination of magnetic resonance imaging (MRI), endorectal ultrasound (ERUS), computed tomography (CT), colonoscopy, and serum carcinoembryonic antigen (CEA) level. The AJCC staging system is standardly accepted for colorectal cancer and is shown in Table 39.1. T and N stage are determined by clinical impression on digital rectal examination (DRE), endoscopy, and MRI or ERUS. DRE has been shown by the MERCURY group to be fairly accurate in locally staging a rectal mass in experienced hands, but is not adequate as the sole modality to determine local stage; rather, it can be helpful to provide a clinical impression and guide further staging. There was debate in the past about the best form of local staging with MRI or ERUS. MRI has been definitively established as the superior method for local staging in most situations. MRI provides both T stage and N stage, and even more importantly visualizes the proximity of the tumour and involved lymph nodes to the mesorectal fascia (circumferential radial margin—CRM). It also offers better visualization of potential invasion of surrounding structures in the case of locally advanced disease, such as the pelvic side wall and sphincters. MRI is thus preferred for routine staging of rectal cancer in order to best determine CRM status and mesorectal and extramesorectal pelvic lymph nodes. In addition, experienced radiologists and improved MRI techniques have now allowed for the detection of extramural vascular invasion, tumor budding, and extrarectal tumor deposits, all of which may more accurately guide the recommendation for the role of neoadjuvant chemoradiotherapy. The use of ERUS without MRI for rectal cancer should be limited to early T stage tumors or very advanced adenomas, where it may provide better resolution. It must be noted that

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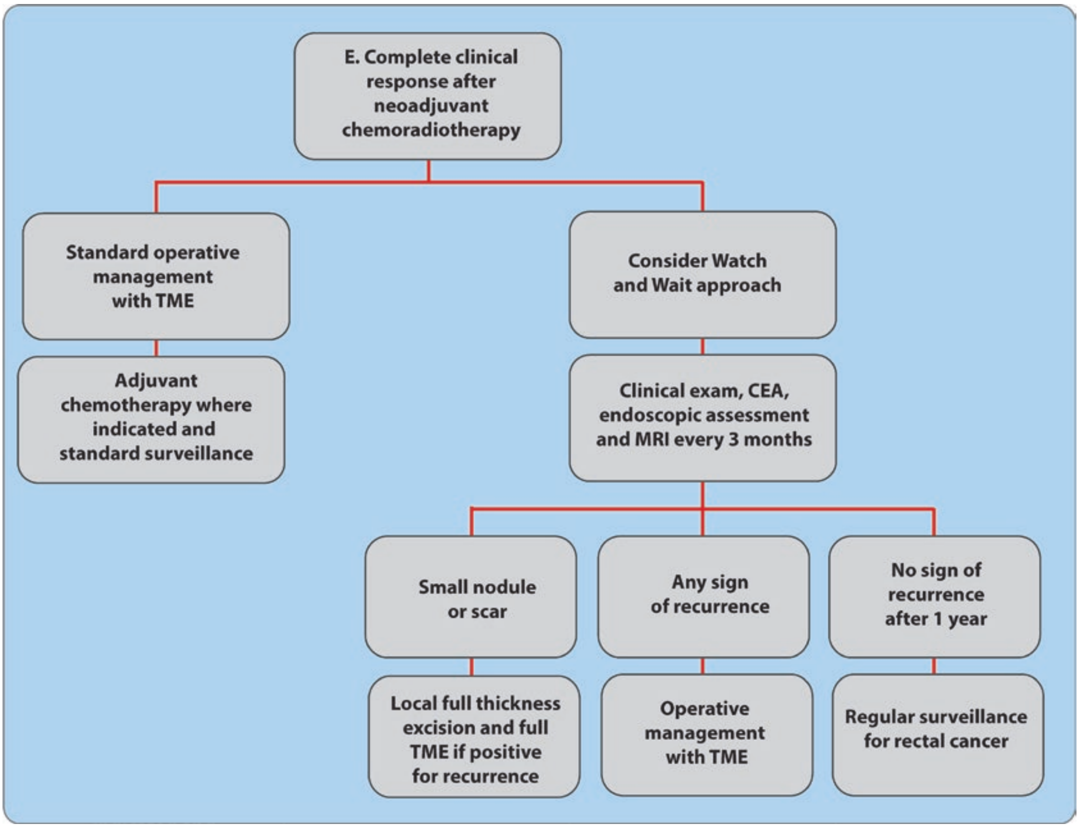

Fig. 39.1 Algorithm for management of a complete clinical response after neoadjuvant treatment. *TME* total mesolectal excision

the accuracy and utility of both MRI and ERUS staging are highly dependent on the expertise of the interpreter, and one must account for local expertise when choosing the staging modality and considering their results. A CT of the thorax, abdomen, and pelvis is recommended for assessment of any metastatic disease. Extramesorectal disease may be surgically resectable and should involve input from a multidisciplinary tumor board in choosing the sequence of potential treatments. The concepts of resectable and curable metastatic rectal cancer have resulted in major shifts in treatment paradigms and heavily utilize both neoadjuvant and adjuvant treatment. This issue will be discussed in further detail later in the chapter.

C. Neoadjuvant Chemoradiotherapy

Following staging, a decision must be made about the need for neoadjuvant chemoradiotherapy. According to the National Comprehensive Cancer Network (NCCN) guidelines for the treatment of rectal cancer, all patients who are locally staged as T3 N0, or Tany N1-2, or T4 should undergo neoadjuvant therapy. However, the benefit of radiation in patients with a clear CRM and no suspicious lymph nodes on staging MRI is limited. As mentioned earlier, MRI has been demonstrated to be highly accurate in the interpretation of the CRM status. Radiation is not benign or without potential morbidity. Complications of radiation include diarrhea, radiation enteritis, radiation proctitis, perianal skin irritation, anastomotic leak, and secondary malignancies. Neoadjuvant therapy can also alter final pathology and make the role for adjuvant therapy questionable in those who have seemingly been downstaged on final surgical pathology, when compared to pre-operative MRI stage of

Table 39.1 AJCC staging system for colorectal cancer (8th Edition)

Primary tumour (T)	
Tx	Primary tumour cannot be assessed
T0	No evidence of primary tumour
Tis	Carcinoma in situ: intramucosal carcinoma
T1	Tumour invades submucosa
T2	Tumour invades muscularis propria
T3	Tumour invades through muscularis propria into pericolorectal tissue
T4a	Tumour penetrates to the surface of the visceral peritoneum (including gross perforation of the bowel through tumour and continuous invasion of tumour through areas of inflammation to the surface of the visceral peritoneum)
T4b	Tumour directly invades or is adherent to other organs or structures
Regional lymph nodes (N)	
Nx	Regional lymph nodes cannot be assessed
N0	No regional lymph node metastasis
N1	One to three regional lymph nodes are positive (tumour in lymph nodes measuring –/> 0.2mm), or any number of tumour deposits are present and all identifiable lymph nodes are negative
N1a	One regional lymph node is positive
N1b	Two or three regional lymph nodes are positive
N1c	No regional lymph nodes are positive, but there are tumour deposits in the subserosa, mesentery, or nonperitonealized pericolic, or perirectal/mesorectal tissues
N2	Four or more regional lymph nodes are positive
N2a	Four to six regional lymph nodes are positive
N2b	Seven or more regional lymph nodes are positive
Distant metastasis (M)	
M0	No distant metastasis by imaging, etc.: no evidence of tumour in distant sites or organs
M1	Metastasis to one or more distant sites or organs or peritoneal metastasis is identified
M1a	Metastasis to one organ or site is identified without peritoneal metastasis
M1b	Metastasis to two or more sites or organs is identified without peritoneal metastasis
M1c	Metastasis to the peritoneal surface is identified alone or with other site or organ metastases

disease. These issues have led many practitioners to adopt more selective use of radiotherapy based on MRI stage, with particular focus on the status of the CRM. With improvement in the quality of surgery and obtaining a high quality total mesorectal excision (TME) in the mesorectal specimen, neoadjuvant chemoradiotherapy may be of limited benefit in patients with T3N0 disease and a clear CRM, when weighed against the short- and long-term risks of radiation, as well as the extended treatment time for the patient with rectal cancer. High quality surgery with a complete TME has been shown to have the greatest impact on local recurrence, with rates well below 10% seen regardless of the use of neoadjuvant therapy. High quality MRI reporting in conjunction with high quality surgery is essential. With accurate preoperative staging, it has been shown by the MERCURY Study Group and others that a clear CRM is likely more important in predicting local recurrence then are T and N staging. The role of accurate staging in order to select patients for neoadjuvant chemoradiotherapy cannot be over stated, as understaged disease may result in the need to consider chemoradiotherapy in the postoperative setting, putting patients at risk of anastomotic leak, stricture, anterior resection syndrome, and perineal wound complications.

Early studies of rectal cancer outcomes found locoregional recurrence rates of 30–40%. The addition of adjuvant radiotherapy attempted to lower local recurrence rates. The benefits of total mesorectal excision were demonstrated by Dr. R. J. Heald who showed that surgical resection in the proper mesorectal plane to achieve a negative CRM could

drop the rate of locoregional recurrence to 5–7%. The role of adjuvant radiotherapy was subsequently questioned, especially for upper rectal lesions and early stage disease. Later studies found that even with a good surgical TME, radiotherapy, particularly in the neoadjuvant setting, could still significantly impact upon the positive CRM and locoregional recurrence rates.

The German Rectal Cancer Study, published in 2004, provided the evidence to move chemoradiotherapy from the adjuvant to neoadjuvant setting. Results showed that there was a significantly lower local recurrence rate with neoadjuvant therapy, but overall survival and disease free survival rates were similar. Given the potential negative impacts of exposing a low anastomosis or perineal wound to postoperative radiation, this significantly changed the algorithm for rectal cancer management in locally advanced disease. Currently, neoadjuvant therapy continues to attract much interest and research in determining the optimal delivery. Standard neoadjuvant therapy involves delivering 1.8 Gy per day, five fractions per week, for a total of 50.4 Gy, consistent with the German Rectal Cancer Study.

Neoadjuvant short course radiotherapy (SCRT) was developed in the 1990s and is currently used in many institutions in the place of standard long course neoadjuvant chemoradiotherapy in select patients. SCRT involves a higher daily dose of radiation, but over a shorter time frame (25 Gy in 5 fractions over only 5 days) and without chemotherapy. Comparative studies of SCRT, including the Swedish Rectal Cancer Trial, Dutch TME Trial, and the MRC Trial, have shown that SCRT is more effective than surgery alone in terms of local recurrence rates. The Polish study and the TROG trial have shown it to be equivalent to standard long course chemoradiotherapy in terms of local recurrence, overall survival, distant metastases, and late toxicity. SCRT is not used for downstaging, and subsequently less pathological complete response is seen. It is therefore not recommended by NCCN for T4 tumours. Downstaging may be an important consideration in the surgical management of rectal cancer in patients with borderline resectable disease, T4b disease, and very bulky tumors. If downstaging is a potential goal in such patients, long course chemoradiotherapy should be chosen over short course radiotherapy. In addition, some patients may not be able to tolerate standard long course neoadjuvant chemoradiotherapy due to confounders such as medical comorbidities, symptoms related to the rectal cancer such as bleeding or impending obstruction, anticipated toxicity or side effects of radiosensitizing chemotherapy, or travel distance to the closest center providing radiotherapy. It may be more appropriate to consider such patients for SCRT as well. These decisions require discussion with the patient and input from multidisciplinary tumor boards. It is most important to recognize the roles, risks, and benefits of both SCRT and long course chemoradiotherapy and consider both modalities of delivering neoadjuvant treatment to the individual patient.

Neoadjuvant chemotherapy regimens administered during radiotherapy have not been as standardized as radiotherapy. A commonly used regimen involves the use of infusional fluorouracil (FU) during the first and fifth week of radiation therapy. Other regimens that have been suggested include bolus 5-fluorouracil (5-FU) with leucovorin and oral capecitabine. Bolus 5-FU with leucovorin has been shown to be effective, but may result in greater toxicity and infusional 5-FU has been shown to be more effective in the adjuvant setting. Capecitabine is an oral prodrug of fluorouracil. It is metabolized in the liver into fluorouracil and is taken twice per day, 5 days per week during radiation therapy. The ease of administration, avoidance of intravenous lines, and lower toxicity has made it the standard neoadjuvant chemotherapy in rectal cancer. The efficacy of capecitabine has been shown in randomized trials (NASBP trial R-04) to have similar local recurrence, overall survival, and downstaging rates as infusional 5-FU. Some caution is required in the use of

capecitabine as it may be metabolized differently between individuals, but we otherwise recommend its use over infusional 5-FU in the neoadjuvant setting. Various trials have experimented with administering infusional oxaliplatin with FU or capecitabine, but the benefit of concurrent use is still unclear. Oxaliplatin increases the toxicity of the chemotherapy regimen and does not appear to affect overall survival when used for a short course in the neoadjuvant setting. NCCN guidelines currently recommend either infusional FU or capecitabine and not bolus FU with leucovorin or the addition of oxaliplatin to chemotherapy regimens.

D. Total Neoadjuvant Therapy

Recently, the concept of total neoadjuvant therapy has been introduced. With long course neoadjuvant chemoradiotherapy, patients often wait 5 months or longer from their diagnosis before they receive full dose systemic chemotherapy in the adjuvant setting. This wait can be even longer if any surgical or radiation related complications occur. Additionally, up to 50% of patients may not complete adjuvant chemotherapy after neoadjuvant chemoradiotherapy and surgery. This may be the result of patient choice or failure to complete proposed adjuvant therapy due to side effects, complications, or treatment fatigue. Total neoadjuvant therapy has been proposed to improve the pathological complete response rate and ensure that all patients who would benefit from systemic chemotherapy receive it in a timely fashion and at a time when they would be most likely to complete the recommended cycles.

The addition of neoadjuvant chemotherapy after chemoradiation was studied in the Timing of Rectal Cancer Response to Chemoradiation trial. The pathological complete response rate was 18% for standard long course chemoradiation therapy alone, 25% for long course chemoradiation therapy followed by 2 cycles of 5-FU, leucovorin, and oxaliplatin (FOLFOX), 30% for long course chemoradiation therapy followed by 4 cycles of FOLFOX, and 38% for long course chemoradiation therapy followed by 6 cycles of FOLFOX. Additionally, better compliance was seen in patients receiving neoadjuvant rather than adjuvant chemotherapy. Long term data showed improved disease free survival rates, but no difference in overall survival with the addition of neoadjuvant chemotherapy. These findings are similar to other published studies showing an improvement in pathological complete response and compliance with chemotherapy. Currently, the randomized phase II/III PROSPECT trial is in progress and will assess the time to local recurrence and disease free survival of patients randomized to either neoadjuvant chemotherapy or neoadjuvant chemotherapy with or without neoadjuvant chemoradiation therapy (dependent on tumour response on imaging to chemotherapy).

Total neoadjuvant therapy appears to be a feasible option for the management of rectal cancer and has been included in the NCCN guidelines as a possible treatment strategy. With improved pathological complete response rates and compliance with chemotherapy, this has the potential to improve survival in patients with rectal cancer.

E. Complete Clinical Response to Neoadjuvant Chemoradiotherapy

Neoadjuvant therapy may lead to complete pathological response in 16–27% of cases submitted to surgery. Although surgical resection for rectal cancer remains the standard of care, the phenomenon of complete response has led to the so-called “watch and wait” approach in select patients with distal rectal cancers who achieve a complete clinical response with neoadjuvant chemoradiotherapy (Fig. 39.1). This approach may be appealing to many patients, especially those who may not tolerate surgery or those who would require an abdominal perineal resection to obtain appropriate margins and wish to avoid a permanent colostomy. A complete clinical response is considered when there is no clinical, endoscopic, or radiographic evidence of residual tumour after completion of neoadjuvant therapy. Unfortunately, a com-

plete clinical response is not always indicative of a complete pathologic response. Up to 33% of patients with a complete clinical response will have cancer present in the surgical specimen upon proctectomy or biopsies of the residual scar endoscopically. Habr-Gama and her group were the first to report on their experience with the watch and wait approach in selected patients who had a complete clinical response after neoadjuvant long course chemoradiotherapy and published promising results with a complete clinical response rate of 49%. Five-year follow up data showed a local regrowth rate of 31%, correlating well with the reported rate of persistent disease of 33% in other trials. Other groups have published varying data on the watch and wait approach. The variability in results can be attributed to heterogeneity in patient selection, variable follow up in terms of time frame and imaging modalities, and different definitions of complete clinical response. Given the regrowth rate and poor correlation of complete clinical response with complete pathologic response, more data are required to both properly select appropriate patients and to optimally monitor those patients in the long term who have chosen the watch and wait approach. A standardized surveillance regimen has not been established. One suggested surveillance program includes assessment of the tumour 8 weeks following the completion of neoadjuvant therapy with clinical exam, endoscopic assessment with biopsies of suspicious areas, CEA level, and MRI of the rectum (Fig. 39.1). If a complete clinical response is demonstrated, close surveillance of the area should be initiated and should include clinical examination, endoscopic assessment, and CEA levels every 3 months for the first year. MRI should also be used to assess for residual tumour or regrowth and it has been suggested that imaging should be performed every 3 months for the first year as well and then at longer intervals thereafter. Patients must understand and commit to this very close surveillance program. Most failures of the watch and wait approach are detected within the first year, and so experts suggest that the surveillance intervals can be lengthened to similar surveillance guidelines that follow standard surgical resection for rectal cancer after 1 to 2 years. If there is a concerning nodule or lesion detected that does not prove to be adenocarcinoma on biopsy, the patient may be taken to the operating room for a local, full thickness excision to determine if the area is indeed tumor regrowth. If so, the patient likely should undergo a proctectomy with a complete TME. The watch and wait approach is relatively new and there are outstanding issues that will be standardized in the future, including the definition of a complete clinical response, time from neoadjuvant therapy to first assessment, appropriate surveillance regimen, and the use of consolidation chemotherapy in the wait and watch patient population. There may also be some benefit to providing combination chemotherapy upfront with radiation therapy in patients who are being considered for the watch and wait approach. As there are many ongoing trials to address these issues, patients who are considered potential candidates for the watch and wait approach must be properly counseled on standards of care in rectal cancer treatment algorithms and our current knowledge gaps in the literature on the long-term outcomes.

F. Timing of Surgery Following Neoadjuvant Chemoradiotherapy

The optimal timing of surgery following neoadjuvant therapy has not been determined. For SCRT, surgery is usually performed within 1 week as was outlined in the Swedish Rectal Cancer Trial. However, the recently published Stockholm III trial suggests that SCRT with a delay of 4–8 weeks or longer results in similar oncologic results as SCRT with immediate surgery or long course chemoradiotherapy and reduces postoperative complications. For standard long course chemoradiotherapy therapy, the interval between finishing neoadjuvant therapy and surgery continues to be investigated, as there can be significant tumour regression following the completion of neoadjuvant therapy. This interval was originally established at

4–6 weeks, as this time period was shown to lead to a higher number of pathological complete responses than patients which had surgery after 2 weeks. This interval is now being extended up to 12 weeks following the completion of neoadjuvant therapy. An interval of 9–12 weeks has been shown to affect the pathological complete response rate for locally advanced rectal cancers, but not early tumours (T1-3 N0). However, an improvement in overall survival has not been demonstrated with a longer time interval. Certainly, waiting longer may allow for neoadjuvant therapy to continue to induce further cellular response, but comes at the expense of balancing resolution of radiotherapy-induced inflammation and tissue friability against pelvic scarring and surgical dissection difficulty. The authors wait approximately 10–12 weeks from the completion of radiotherapy to surgical resection date, but there is clear variability among centers and surgeons.

G. Adjuvant Chemotherapy

Following surgical resection, adjuvant chemotherapy is indicated in all patients who have received neoadjuvant chemoradiotherapy. In the past, all chemotherapy was administered in the adjuvant setting, until the German Rectal Cancer Study provided definitive evidence to support neoadjuvant treatment in appropriate patients. Commonly, only 5-FU is used in the neoadjuvant setting as a radiosensitizer, rather than additional combination chemotherapy, again highlighting one of the goals of neoadjuvant chemoradiotherapy to reduce local recurrence, but not improve survival. Therefore, after neoadjuvant chemoradiotherapy and surgery, patients are usually considered for 3–6 months of adjuvant combination chemotherapy. The evidence for 5-FU based chemotherapy, with or without oxaliplatin, in the adjuvant setting when neoadjuvant chemoradiotherapy has been administered has been questioned and the evidence is sparse. Despite this dilemma, adjuvant chemotherapy continues to be the standard recommendation in locally advanced rectal cancer. Combination chemotherapy usually consists of 5-FU, leucovorin, and oxaliplatin (FOLFOX). Regimens involving irinotecan have also been investigated and there is no strong evidence for its use. Bevacizumab, cetuximab, and panitumumab have not been shown to be beneficial in the adjuvant setting unless there is hepatic metastatic disease. There may be significant downstaging with neoadjuvant chemoradiotherapy and the post treatment pathological stage may not reflect the pre-treatment stage. This staging discordance may subject some patients to combination chemotherapy who otherwise would not have received it and highlights the need for continued improvements in the accuracy of preoperative staging. Further studies are needed to address the use of adjuvant chemotherapy and clarify which patients will benefit most from its use.

Patients with stage II and III disease who had not received neoadjuvant chemoradiotherapy prior to surgery likely should receive adjuvant radiotherapy and combination chemotherapy following surgical resection to help prevent locoregional recurrence and distant disease. This therapeutic schema includes patients in whom the tumour was upstaged upon pathologic assessment, those who underwent an emergency operation without the possibility of receiving neoadjuvant therapy, and those who underwent a local excision and do not wish to proceed with definitive surgery for T2 or T3 lesions. Radiotherapy should be combined with a radio-sensitizer such as capecitabine or infusional 5-FU. Combination chemotherapy should be 5-FU based, such as FOLFOX. The optimal sequencing of treatments has not been established in this situation. Postoperative radiation therapy may lead to problems with anastomotic strictures, radiation proctitis or enteritis, and perineal wound breakdown in the event of an abdominoperineal resection, and thus should be carefully considered. It is important to ensure that small bowel is kept out of the radiation fields where possible.

H. Metastatic Rectal Cancer

Stage IV colorectal cancer was historically approached with a palliative intent. Metastasectomy for single organ metastases such as from the liver or lung, however, has

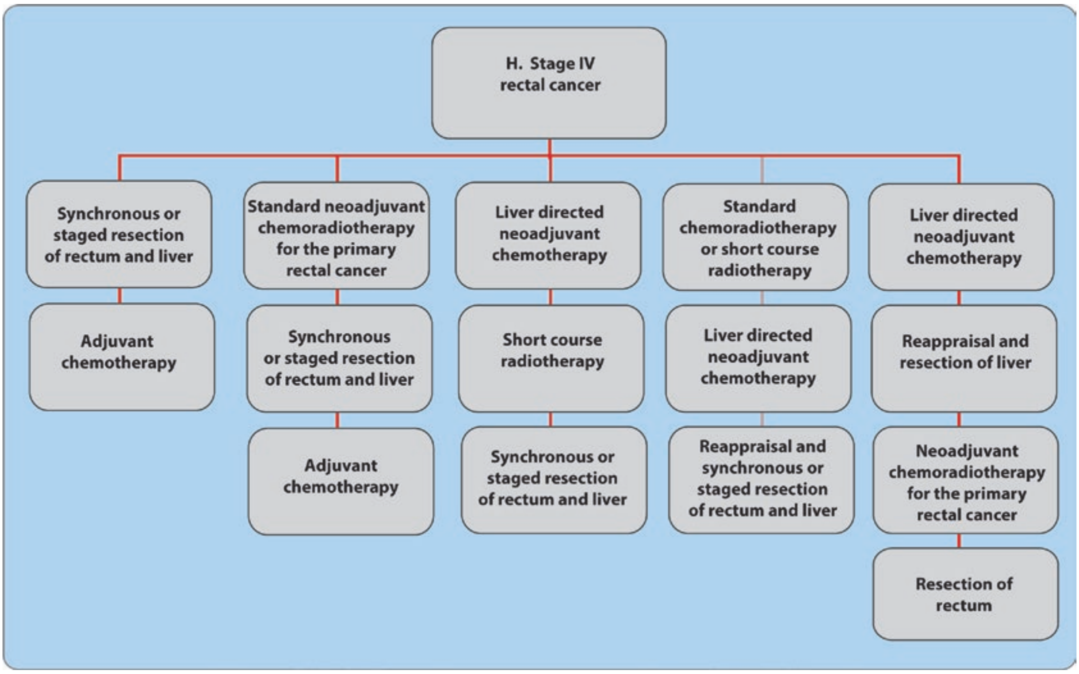

Fig. 39.2 Treatment options in stage IV rectal cancer with resectable disease. Additional less common treatment sequences not shown here may be potential options in appropriate patients

been shown to be with both an overall survival and disease-free survival advantage in many patients. The indications for more aggressive surgical approaches to metastatic disease continue to expand. Extensive liver resections, multiple site resections (for example, lung and liver resections in patients with metastatic disease), and cytoreductive surgery with intraoperative chemotherapy for peritoneal carcinomatosis, have radically changed the approach to patients with stage IV disease. While this group still has an overall poor prognosis, long term overall survival and disease-free survival have been reported to be approximately 25 percent in patients who are carefully selected for multimodality approaches where the metastatic disease is limited and amenable to surgical resection. Neoadjuvant chemoradiotherapy and adjuvant chemotherapy play important roles in the management of stage IV rectal cancer and the timing of therapy is on ongoing area of research.

In the event of stage IV rectal cancer and resectable metastatic disease, the sequence of treatments may significantly vary between patients based on the nuances of the location and burden of disease at the primary and metastatic sites, symptoms, and patient comorbidities; thus, the input from a multidisciplinary tumor board and a team-based approach to patients are essential. Possible pathways for patients with liver metastases are summarized in Fig. 39.2 and include the following:

1. Synchronous resection of the rectum and liver followed by adjuvant chemotherapy. This sequence is used in patients who do not require downstaging of disease at either site and are well. In unwell patients, a staged resection should be performed and may start with the liver or rectum.
2. Standard neoadjuvant chemoradiotherapy for the primary rectal cancer followed by synchronous resection of the rectum and liver and then adjuvant chemotherapy. This sequence is used in patients who require downstaging of the primary rectal cancer. This sequence can be altered by performing a staged resection with the liver resection preceding the neoadjuvant chemoradiotherapy. In unwell patients, a staged resection

should be performed after neoadjuvant chemoradiotherapy.

3. Liver directed neoadjuvant chemotherapy followed by short course radiotherapy for the primary rectal cancer and then synchronous resection of the liver and rectum. This sequence is used in patient who require downstaging of the liver disease. In unwell patients, a staged resection should be performed with the liver first and then followed by the rectum.
4. Standard neoadjuvant chemoradiotherapy or short course radiotherapy followed by liver directed neoadjuvant chemotherapy followed by reappraisal and synchronous resection if determined to be resectable. This sequence is used in patients with potentially resectable disease who need downstaging of both the rectum and liver. In patients who are unwell, this sequence may be altered by starting with liver directed neoadjuvant chemotherapy followed by reappraisal and resection of the liver if resectable, followed by chemoradiotherapy for the primary rectal cancer and resection of the rectum.

These pathways may also be used for patients with pulmonary metastases and require the input from multidisciplinary teams involving thoracic surgeons.

The resection of the primary rectal cancer and the metastatic disease may occur in staged or synchronous fashions. Staged resections have traditionally involved resecting the primary rectal cancer first followed by the metastatic disease, but resection of metastases first may be an effective approach and can be performed, especially if the metastatic disease is resectable at presentation but relatively high burden. Synchronous resection allows for the patient to undergo one combined operation and then proceed on to adjuvant chemotherapy sooner, but clearly adds to the complexity and potential complications of that large combined operation. Up front combination chemotherapy may provide the best chance to control and eradicate distant and microscopic disease and may covert borderline and unresectable metastases into resectable metastases. It will also identify patients who respond well to chemotherapy as well as those who will have progression of disease despite being treated. This sequence might allow one to avoid unnecessary aggressive surgical interventions for the primary cancer and metastatic disease and their potential complications in patients whose poor tumor response to chemotherapy declare these patients to be poor candidates for curative intent while on chemotherapy. It is important to remember that stage IV disease is not curable most of the time, and each patient must be carefully considered with input from medical oncology, radiation oncology, colorectal surgery, and hepatobiliary or thoracic surgery to properly navigate these very complicated treatment sequencing options.

Combination chemotherapy in patients with stage IV disease should be 5-FU based, as is used for adjuvant chemotherapy and described earlier. FOLFOX or FOLFIRI can be used. The addition of irinotecan to FOLFOX (FOLFOXIRI) has shown some benefit in converting upfront unresectable liver disease into resectable. Vascular endothelial growth factor (VEGF) and epidermal growth factor receptor (EGRF) inhibitors also have potential roles in the management of stage IV disease by medical oncology. These monoclonal antibodies have not been shown to be useful in stage I-III colorectal cancer, but do confer both an overall survival and progression free survival advantage for patients with stage IV disease. Bevacizumab is a VEGF inhibitor and can be used either pre-operatively or post-operatively. If such an agent is preoperatively used, surgery should be delayed for at least 5 weeks after completion to avoid the known complications of VEGF inhibitors. These complications include intestinal perforation, bleeding, impaired wound healing, and arterial thromboembolic disease. Cetuximab and panitumumab are EGFR inhibitors and are also useful in

stage IV disease. Unlike bevacizumab, however, the EGFR inhibitors are known to be effective only in patients who are wild type *KRAS*. There may even be some harm with the use of cetuximab in patients who have *KRAS* mutations. Patients with potentially resectable disease who are undergoing up front combination chemotherapy should be re-imaged every 2 months to assess response of the metastatic disease and the primary tumor (if *in situ*) and discussed at multidisciplinary tumour boards as necessary to re-evaluate the efficacy of the treatment pathway.

In patients with unresectable metastatic disease, surgery, chemotherapy and radiotherapy all have potential important indications. Management of symptomatic primary lesions can occur through the use of colonic stents, diversion with colostomy or ileostomy, radiotherapy, or rarely, palliative resection. Chemotherapy is used for a progression free survival benefit in symptomatic patients and once again should be 5-FU based (FOLFOX or FOLFIRI) with the addition of bevacizumab or an EGFR inhibitor where appropriate. The risk of perforation is minimal and this should not prevent the use of bevacizumab in patients that have not undergone resection of the primary rectal cancer. Patients should be re-evaluated after 2 months of therapy to assess the response and determine if they are potentially resectable. Other agents have become available for patients with unresectable disease who have had progression of disease despite treatment with standard chemotherapy regimens, or are intolerant to them. These drugs include regorafenib, an angiogenic tyrosine kinase inhibitor, and trifluridine-tipiracil, which combines a nucleoside analogue and a thymidine phosphorylase inhibitor. Both of these agents have shown marginal benefits.

I. Ileostomy Reversal

Diverting ileostomies have been shown to be effective in reducing clinically important anastomotic leaks as well as mortality in patients who have undergone a proctectomy with a low colorectal or coloanal anastomosis and those who have received neoadjuvant radiation. Following the completion of adjuvant chemotherapy, patients should be considered for reversal of diverting ileostomies. The length of time to reversal has been studied and there is evidence that delaying the reversal past 6 months increases complications such as anastomotic leak and length of hospital stay. Factors that may lead to delayed reversal include adjuvant chemotherapy and anastomotic leak or stricture. The EASY trial was developed to assess the benefits of closing temporary ileostomies at 8–13 days instead of waiting at least 12 weeks or until after adjuvant chemotherapy. The primary outcome being studied in this trial was the rate of complications and it was shown that it is safe to close diverting ileostomies at this early stage in patient who do not have any evidence of an anastomotic leak. Other trials on early ileostomy closure are still ongoing and the timing of ileostomy closure may shorten significantly in the future. Some patients who have had temporary diverting ileostomies performed may never undergo reversal due to anastomotic complications, morbidities following systemic chemotherapy, or patient preference. Prior to reversal, it is important to inspect the anastomosis endoscopically to ensure patency and rule out any obvious early recurrence or anastomotic leak. We also recommend standard use of a water soluble contrast enema to rule out any small anastomotic leak which may precipitate after stoma closure.

J. Multidisciplinary Tumor (MDT) Boards

MDTs have been widely implemented to allow for a thorough discussion of patients with rectal cancer in order to follow an evidence-based multidisciplinary approach to their care. The management of rectal cancer has changed significantly over the years and is still undergoing many changes, as highlighted early in the chapter. Surgeons, radiologists, oncologists, and pathologists commonly comprise these tumor boards and should advocate for each patient to ensure that they receive the best care possible. Each specialty has a role to play in the

discussion and review of the staging and possible treatments. In the United Kingdom and many other European countries, it is mandatory that rectal cancer be treated at a center of excellence and that each patient with rectal cancer is discussed at a multidisciplinary tumor board meeting. This process has led to higher rates of TME and more standardized care. The National Accreditation Program for Rectal Cancer (NAPRC) is a quality program of the American College of Surgeons (ACS) that developed through collaboration between the OSTRiCh Consortium (Optimizing the Surgical Treatment of Rectal Cancer) and the Commission on Cancer (CoC) in the United States. This North American group advocates for multidisciplinary discussion of rectal cancer patients and individualized treatment pathways. Their goal, once again, is to provide more standardized and evidence-based care to all patients with rectal cancer, not just those living close to a "center of excellence", in order to improve cancer outcomes and standards of care. MDTs are a large part of achieving this goal of standardization of care and have also been shown to lead to improved patient outcomes in many other types of cancer such as breast and head and neck cancers. Clearly, the treatment of rectal cancer is complex, especially when one considers the nuances of local stage, distant disease, roles of chemotherapy and radiotherapy, and sequencing of treatments. Multidisciplinary involvement is essential to improving care and optimizing outcomes for all patients with rectal cancer. One of the accreditation standards of the ACS CoC NAPRC is that every patient's particulars are discussed at MDT prior to and after treatment in accredited centers and beyond.

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Rectal Conditions: Stage IV Rectal Cancer

40

Russell C. Langan and Martin R. Weiser

Introduction

Colorectal cancer is the third most common cause of cancer-related death in the United States, with estimates of 147,950 new cases and 53,200 deaths for the year 2020. Approximately 20% of patients present with synchronous disease, while an additional 30% of patients experience metastases over the course of their disease. Recently, the management of both locally advanced and metastatic rectal cancer has undergone a paradigm shift. Our preference for treatment of locally advanced disease is total neoadjuvant therapy, with either induction or consolidation chemotherapy, followed by chemoradiotherapy and total mesorectal excision. However, the treatment algorithms for metastatic disease are less well defined.

The treatment of locally advanced (T3/4 or N1/2) rectal cancer includes chemotherapy, radiation, and surgery. Chemotherapy and radiation are utilized to downsize a rectal tumor and facilitate margin-negative resection in the setting of MRI documentation of a threatened mesorectal margin. Total neoadjuvant therapy, with either induction or consolidation chemotherapy in addition to chemoradiotherapy, followed by total mesorectal excision is a popular treatment strategy. However, such intensive preoperative treatment can delay definitive surgery by 4–6 months. Therefore, alternative approaches are required for metastatic rectal cancer, generally based on liver tumor resectability and the extent of pelvic disease. The decision-making process described below is diagrammed in Fig. 40.1.

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Refer to Algorithm in Fig. 40.1

A. Following the diagnosis of rectal cancer, a thorough disease assessment must take place. Laboratory investigations should include a complete blood count, a complete metabolic panel, and measurement of carcinoembryonic antigen. Radiographic analysis should be completed with high-quality contrast-enhanced cross-sectional imaging (computed tomography) of the chest, abdomen, and pelvis. Local staging generally requires proctoscopy with either endorectal ultrasound or rectal MRI (preferred). If liver metastasis is suspected, we favor liver MRI or triphasic computed tomography of the liver.
B. If widespread metastasis is identified, systemic therapy should be administered as outlined in NCCN guidelines. Per recent EORTC (European Organisation for Research and Treatment of Cancer) consensus guidelines, in patients with unresectable metastatic rectal cancer the primary treatment goal is

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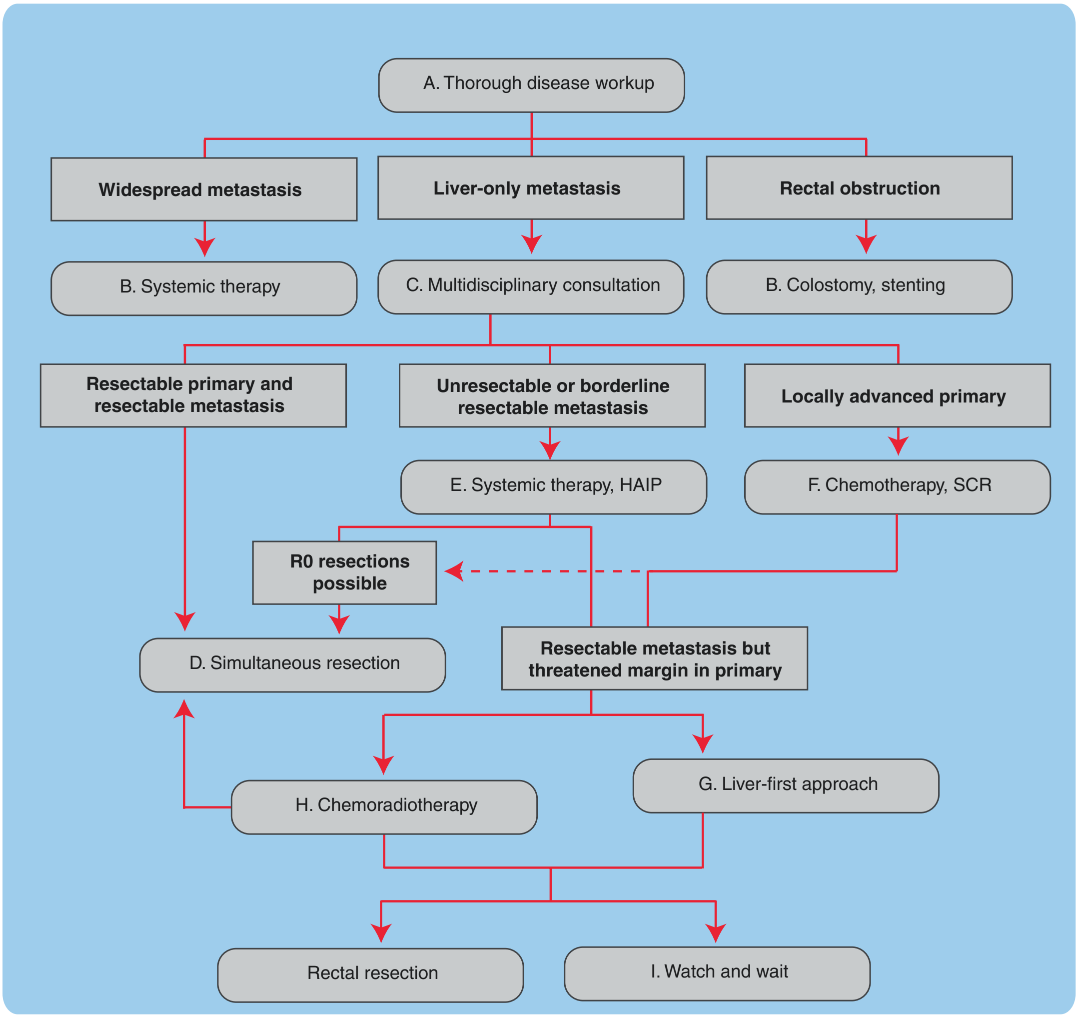

Fig. 40.1 Algorithm for treatment of stage IV rectal cancer. Following the diagnosis of rectal cancer, a thorough disease workup must take place (A). Widely metastatic disease should be treated with systemic therapy per NCCN guidelines (B). If the metastasis is confined to the liver, an early consultation with a hepatobiliary surgical team is warranted (C). There are advantages to resecting the primary tumor and the metastasis simultaneously (D). If the liver disease is borderline resectable or unresectable, systemic therapy with or without hepatic arterial infusion pump (HAIP) therapy should be implemented (E). Short-course radiotherapy (SCR) can be considered for very bulky and low lesions (F). Following therapy, if the liver disease has become resectable and the rectal primary has also regressed to allow for a R0 resection, we favor a simultaneous hepatectomy and rectal resection. However, if the liver disease has become resectable but the rectal primary tumor remains advanced with a threatened mesorectal margin, treatment options vary. One approach is liver surgery first (G), followed by chemoradiation. In the absence of a complete clinical response, pelvic chemoradiotherapy (H) should be administered followed by total mesorectal excision. Alternatively, long-course chemoradiotherapy or short-course radiotherapy with delay for tumor regression can be utilized (if not previously used). If a complete clinical response is achieved in the primary tumor, a nonoperative approach should be considered (I)

maintaining quality of life, alleviating tumor-related symptoms, and minimizing treatment-related side effects. Mortality after resection of the primary tumor in patients with incurable stage IV colorectal cancer is significantly higher than mortality after resection for colorectal cancer in general. For this reason, a conservative approach to the primary tumor, especially in asymptomatic patients, is warranted. Moreover, in patients

with an asymptomatic rectal tumor and synchronous liver metastases, if there is no plan to resect the primary tumor, the EORTC consensus panel recommends against immediate initiation of pelvic radiotherapy.

If there is colonic obstruction, a diverting loop colostomy should be considered. Additionally, endoscopic stenting should be discussed. However, endoscopic stenting options for distal low rectal tumors are limited, as difficulties are present with stent migration, inadequate length for stent fixation, and unrelenting tenesmus. In a randomized study conducted by Fiori et al., 22 patients with stage IV unresectable rectosigmoid cancer and symptoms of subacute obstruction underwent either endoscopic placement of an expandable stent or diverting proximal colostomy and were followed until death. The two groups did not differ in treatment-related morbidity or mortality; however, patients who underwent stenting experienced some benefits in length of stay and restoration of oral feeding and bowel function. Palliative pelvic radiotherapy also has a role, with an overall symptom response rate of 75% according to a systematic review by Cameron et al.

A study conducted at Memorial Sloan Kettering Cancer Center (MSK) examined primary-tumor outcomes in patients with stage IV colorectal cancer treated with upfront systemic therapy. The study found that only 7% of the patients required emergent surgery for primary tumor obstruction or perforation and 4% required nonoperative intervention such as stenting or radiotherapy. Thus, 89% of patients with metastatic colorectal cancer did not need any direct symptomatic management for their intact primary tumor during systemic therapy.

C. If the metastatic disease is confined to the liver, a multidisciplinary discussion and early consultation with a hepatobiliary surgeon are warranted. Optimal treatment for synchronous hepatic metastases, which occur in 15–25% of patients with rectal cancer, is a matter of some disagreement. The principal treatment goal is complete resection of all primary and metastatic lesions with a curative intent, but the choice and sequence of the available treatment modalities depend on the clinical situation. Traditionally, rectal resection is preceded by hepatectomy, with or without perioperative systemic therapy. However, simultaneous resections and liver-first approaches are becoming more common.

D. If the liver metastasis is resectable and the rectal primary tumor is either T1 or T2 with no evidence of nodal disease (N0) or threatened mesorectal fascial margin, we recommend a simultaneous surgical approach. No improvement in progression-free or overall survival has been reproducibly documented for neoadjuvant systemic therapy. In a randomized trial evaluating perioperative FOLFOX versus surgery alone for resectable liver metastases, Nordlinger and colleagues found no difference between chemotherapy plus surgery and surgery alone in median overall survival (61.3 and 54.3 months, respectively; $P = 0.34$) or median progression-free survival (20.0 and 12.5 months, respectively; $P = 0.068$). Our group, therefore, recommends upfront surgical resection for all patients with resectable disease and consideration of postoperative chemotherapy.

Simultaneous resections of both the rectal primary and hepatic disease have been found to be safe and efficacious. Due to improvements in operative and perioperative management, simultaneous liver and colon resections are an accepted approach at specialized centers for selected patients. A recent study conducted at MSK compared survival in 320 patients who underwent simultaneous resections with survival in 109 patients who underwent staged resection. The two groups did not differ in 1- or 5-year overall survival or disease-free survival.

Current evidence supports the feasibility, safety, and equivalent oncologic outcomes of simultaneous curative resection in a well selected patient population. Theoretically, simultaneous resection reduces the need for subsequent major surgery and therefore allows earlier initiation of adjuvant systemic therapy

without possible interruption. More importantly, an upfront simultaneous resection offers the advantage of avoiding injury to the liver from systemic therapy (e.g., oxaliplatin), thus decreasing the risk of postoperative liver failure. All four meta-analyses of simultaneous resections published to date (in 2010–2014) demonstrated lower overall complication rates for simultaneous resections than for staged resections.

E. If borderline resectable or unresectable hepatic disease is identified, systemic therapy is warranted, as is assessment for hepatic arterial infusion pump (HAIP) therapy with floxuridine. In a single-arm trial investigating hepatic arterial infusion pump therapy with floxuridine in 49 colorectal cancer patients with unresectable hepatic metastases, D'Angelica et al. found an overall response rate of 76% and a conversion-to-resection rate of 47%. Median overall survival was 38 months, with progression-free survival of 13 months. It should be noted that the median number of hepatic metastases in this patient population was 14, and 65% of the patients had shown no response to conventional systemic therapy.

F. For locally advanced primary tumors (T3/4, N1/2, with a threatened mesorectal margin), treatment algorithms are less well defined, as tumor down-staging is often necessary to ensure a margin-negative resection. Options include total neoadjuvant therapy (induction or consolidation chemotherapy with chemoradiotherapy) and chemotherapy alone. One possible sequence is neoadjuvant chemotherapy, liver resection, chemoradiotherapy and finally rectal resection. Another strategy recently developed by international consensus is the sequence of neoadjuvant chemotherapy, radiotherapy, hepatic resection, and delayed rectal resection. The theory behind this liver-first strategy is that a delay of at least 8 weeks between radiotherapy and rectal surgery promotes tumor down-staging and increases the chance of a complete response, without increasing surgical complications. Thus, the delay is thought to not disadvantage the patient. The timing of hepatic resection does remain a matter of debate.

Short-course radiotherapy (SCR) offers additional options. This modality involves a flexible schedule of delivering accelerated and hypofractionated intensive radiotherapy in five 25-Gy fractions over 5 days (5 × 5 model). Literature suggests that compliance is high, with side effects such as nausea, diarrhea, proctitis, tenesmus, urinary frequency, dysuria, and erythema/desquamation of the perineum usually experienced only after treatment is completed. Also, the overall treatment time is shortened, since surgery should be performed either within 7 days or after 21 days, avoiding the period of maximum inflammatory response. Another advantage is the potential for lower costs.

A recent systematic review and meta-analysis examined the findings of eight randomized controlled trials for a total of 6894 patients who had undergone SCR. Three trials (n = 3682) compared SCR and selective postoperative radiation alone or combined with chemotherapy. The rates of local recurrence were significantly lower in patients who received SCR (hazard ratio 0.44, 95% confidence interval 0.35–0.56). However, no benefit in overall survival was observed. Two other trials (n = 638) found no statistically significant differences in the rates of local recurrence or overall survival between SCR and long-course chemoradiotherapy. Patients who received SCR had lower rates of grade 3 or 4 acute treatment-related toxicities (relative risk 0.11, 95% confidence interval 0.05–0.22), but no difference in late toxicity was observed. Overall, the data indicate that SCR is a reasonable treatment strategy for resectable locally advanced rectal cancer.

G. Since survival in patients with metastatic rectal cancer is often limited by hepatic disease, a liver-first approach offers the advantage of avoiding delays associated with treatments directed at the primary tumor. Recent data suggest that patients treated with the liver-first approach are more likely to

complete the full treatment protocol and may avoid delays due to complications of rectal surgery. Another advantage is that in a chemo-naïve liver the risk of postoperative hepatic failure is lower. The recent EORTC consensus stated that standard chemoradiotherapy with a fluoropyrimidine-alone chemotherapy backbone likely results in undertreatment of the metastatic disease for a substantial period, which may be further prolonged by postoperative complications if the rectal tumor is removed first. Therefore, the panel recommends against starting the treatment of metastatic (resectable) rectal cancer with radiotherapy.

H. The oncologic benefit of administering pelvic radiotherapy to rectal cancer patients with simultaneous resectable liver metastases has recently been challenged by the findings of an MSK analysis of 185 patients who underwent complete resection of the rectal primary tumor and liver metastases. In that cohort, 97% of patients received chemotherapy during their treatment course and 49% received pelvic radiotherapy either before or after the rectal resection. The 5-year rate of disease-specific survival was 51% for the entire cohort, with a median follow-up of 44 months for survivors. About 70% of patients had a recurrence. However, only 10% of all patients had a pelvic recurrence in combination with other sites, and only 4% of patients had an isolated pelvic recurrence. A competing risk analysis found that the likelihood of a pelvic recurrence was significantly lower than that of an extrapelvic recurrence ($P < 0.001$). The authors concluded that selective exclusion of radiotherapy is appropriate in rectal cancer patients with liver metastases.

Additional support for the use of chemotherapy and selective pelvic radiotherapy comes from an MSK retrospective review demonstrating that FOLFOX chemotherapy can serve as a substitute for pelvic radiotherapy. The patients received preoperative FOLFOX without chemoradiotherapy as initial management of locally advanced rectal cancer (because of suspected metastatic disease, relative contraindications to radiotherapy, or patient refusal of radiotherapy). Six patients with stage II or III rectal cancer received preoperative FOLFOX, and 14 patients with synchronous metastatic colon or rectal cancer received preoperative FOLFOX alone or in combination with bevacizumab, followed by resection of the primary tumor. Overall, in 35% of patients the primary tumor had a pathologic complete response. Moreover, of the six patients who received only FOLFOX, two had a pathologic complete response and three had treatment effects of 99%, 95%, and 90%, respectively. These findings highlight the value of chemotherapy for locally advanced rectal cancer and call into question the necessity of reflexive chemoradiotherapy for locally advanced or metastatic rectal cancer.

The ongoing PROSPECT trial (Preoperative Radiation or Selective Preoperative Radiation and Evaluation before Chemotherapy and TME) challenges the current treatment paradigm and attempts to individualize treatment by using radiotherapy selectively rather than reflexively. In this phase II/III multicenter trial, neoadjuvant FOLFOX with selective use of fluorouracil and pelvic radiation is being tested against the current standard of upfront fluorouracil and pelvic radiation for rectal cancer patients undergoing low anterior resection with total mesorectal excision. By randomizing patients to the two arms, the PROSPECT trial provides an opportunity to reduce the use of pelvic radiation in patients who might not benefit from it.

I. Another argument to choose a liver-first strategy is the possibility of rectum preservation with a watch-and-wait strategy in patients whose primary tumor has a clinical complete response to chemotherapy and chemoradiation. In an MSK analysis of 145 patients with stage I to III rectal cancer, 73 patients had a clinical complete response (no detectable tumor by clinical exam, endoscopy, or imaging) after neoadjuvant chemoradiotherapy and were treated nonoperatively. This cohort was then compared to 72 matched patients

treated conventionally who achieved a pathologic complete response and underwent total mesorectal excision. (Of note, neoadjuvant therapy administered to the nonoperative patients was not standardized in this retrospective series.) Although all patients received pelvic radiation (45–55 Gy) plus a fluoropyrimidine, beginning in 2011 most received induction FOLFOX followed by chemoradiotherapy and then assessment for surgery. Patients with clinical complete response were offered the nonoperative, watch-and-wait approach, which included frequent monitoring with clinical and endoscopic exams every 3 months and cross-sectional imaging every 6 months.

After a median follow-up of 3.5 years, 74% of the 73 watch-and-wait patients achieved a durable and sustained clinical complete response. The 19 patients (26%) who had local recurrence underwent salvage surgery. One patient had a recurrence after salvage surgery. Thus, the local control rate was 98%. Overall, 77% of patients were able to complete treatment with rectum preservation, and this conservative approach did not compromise outcomes. A phase II multicenter randomized trial is currently investigating the use of neoadjuvant treatment for locally advanced rectal cancer and the use of nonoperative management in patients with clinical complete response.

More recently, International Watch and Wait Database data from 775 patients from 11 countries and 35 participating institutes was presented at the 2017 annual meeting of the American Society of Clinical Oncology. Induction treatment (chemoradiotherapy in 90% of cases) produced a clinical complete response in 90% of the patients, and those patients were included in the analysis. With a median follow-up of 2.6 years, local regrowth occurred in 25% (n = 167) of patients. Of note, 84% of the occurrences of local regrowth occurred within the first 2 years of follow-up. The 3-year overall survival rate was 91% for the full cohort and 87% for patients with local regrowth.

Although the patients in this cohort did not have metastases, we believe the watch-and-wait treatment strategy can be extrapolated to stage IV rectal cancer with resectable hepatic metastases.

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Rectal Cancer: Watch and Wait

41

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Refer to Algorithm in Fig. 41.1

A. In up to 42% of patients undergoing neoadjuvant chemoradiotherapy (nCRT) for advanced rectal cancer, complete tumor regression may develop depending on variables including baseline features and specific treatment regimens.
B. Patients with complete clinical response (cCR) based on clinical (including digital rectal examination), endoscopic and radiological findings have been offered no immediate radical surgery. Instead, it has been suggested that strict surveillance, also known as the "Watch and Wait" (WW) strategy, with frequent reassessment of tumor response by an experienced colorectal surgeon and radiological imaging could provide safe and acceptable oncological outcomes.
C. Clinical assessment of tumor response can accurately detect pathological response when stringent criteria are used. These findings include the absence of any residual ulcer, mass or stenosis and only clinically detectable whitening of the mucosa, telangiectasias and/or slight induration of the rectal wall.
D. On the other hand, the low overall sensitivity of these features in identifying a pCR will inevitably lead to a significant proportion of patients that still undergo radical surgery in the presence of incomplete clinical response, but complete pathological response.
E. In addition, clinical/endoscopic findings should be further supported by radiological imaging preferably by high-resolution Magnetic Resonance or alternatively, PET-CT showing no evidence of residual disease.
F. Digital rectal examination (DRE) is perhaps one of the most relevant tools in tumor response assessment. In terms of DRE, a cCR is the absence of any irregularity of the rectal wall. There is currently no single diagnostic tool that can possibly replace the information given by DRE. Very frequently, irregularities of the rectal wall are better felt than seen, and should be considered as highly suspicious for residual cancer. In the presence of rectal wall irregularities, mass ulceration or stenosis, patients are recommended standard radical resection. The area can be thickened and firm, but to be considered a cCR, the surface has to be regular and smooth.
G. Endoscopic assessment is also very important. Whitening of the mucosa and telangiectasia are usually seen in patients with a cCR (Fig. 41.2). The presence of any ulceration or mucosal irregularity missed on DRE should

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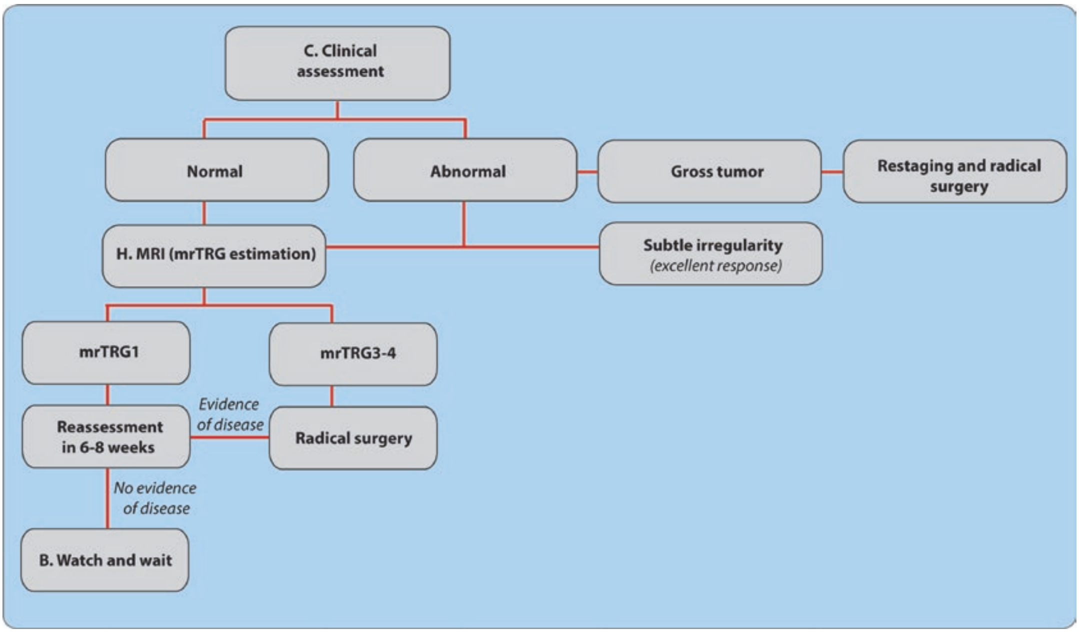

Fig. 41.1 Algorithm for Watch and Wait

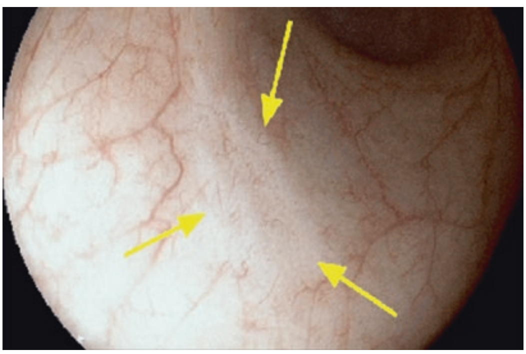

Fig. 41.2 Endoscopic view of rectal cancer that developed complete clinical response after neoadjuvant chemoradiation, showing whitening of the mucosa and telangiectasia

prompt additional investigations and usually rule out a cCR.

H. Magnetic Resonance (MR) imaging should be routinely used for the assessment of response in patients after CRT. Currently, we would only consider a true complete responder in a patient showing low signal intensity area replacing the area of the previous tumor and no evidence of disease on clinical and endoscopic examination (Fig. 41.3). The presence of mixed signal intensity within the area of the previous cancer should raise a suspicion of an incomplete clinical response. In addition to the assessment of the rectal wall, the mesorectum is also at risk for the presence of residual cancer despite complete primary regression (ypT0N1). Therefore, MR imaging should also provide the colorectal surgeon with information regarding possible mesorectal (or even lateral node) involvement regardless of primary tumor response.

I. PET/CT has been used for the assessment of tumor response to neoadjuvant chemoradiation therapy. It offers information on tumor metabolism in addition to standard radiological anatomical features. Recently, it has been suggested that combination of tumor volume and metabolism reduction provided by sequential PET-CT imaging (before and after CRT) may be a useful predictor of complete tumor response to treatment.

J. Timing of assessment after CRT completion may also be relevant. Longer intervals were originally thought to be associated with higher pCR rates. However there are conflicting data suggesting that longer intervals may

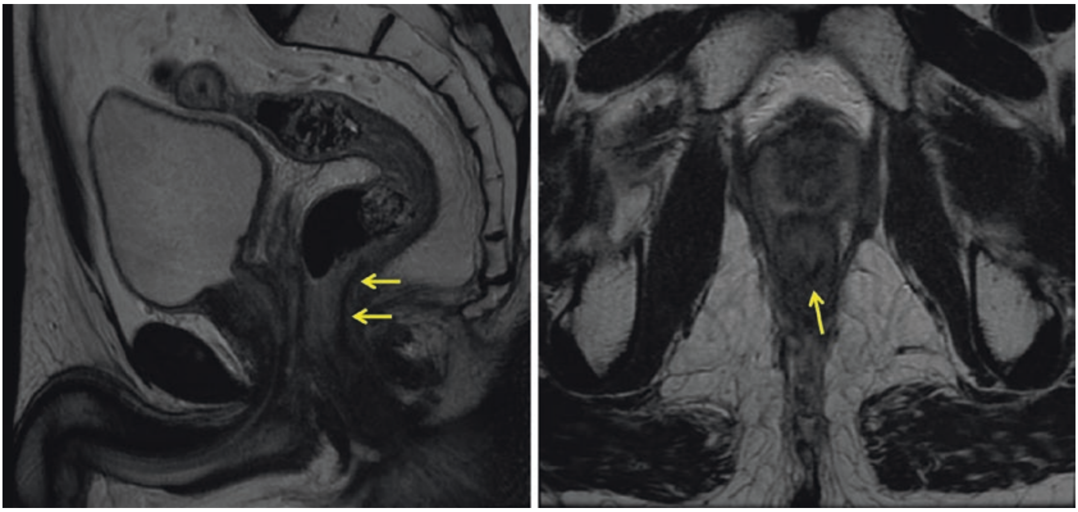

Fig. 41.3 MR imaging of rectal cancer after neoadjuvant treatment showing complete radiological response, as low signal intensity

or may not increase tumor response. Accordingly, there are data to support that longer intervals may increase or not postoperative morbidity. It has been our practice to assess tumor response after at least 8–10 weeks after CRT completion.

K. Endoscopic forceps biopsies may be misleading. It has been our practice to AVOID endoscopic biopsies in the presence of a complete clinical response. In the presence of incomplete clinical response, positive biopsies (of residual adenocarcinoma) may provide confirmation of residual cancer at that particular time period after CRT completion. However, negative biopsies (for residual adenocarcinoma) rarely correlate to the presence of complete pathological response. Therefore, patients should not be considered a cCR based on findings of negative endoscopic biopsies.

L. Transanal local excision or full excisional biopsy of the residual lesion is a powerful diagnostic tool. It provides adequate and complete pathological information regarding the ypT status, tumor regression grade, differentiation, and other pathological features. However, it may also have significant disadvantages including frequent wound dehiscences and considerable associated rectal pain.

M. Therefore, when deciding between local excision and observation alone for the management of patients with cCR following neoadjuvant CRT, one has to balance the benefits of pathological confirmation of a complete pathological primary tumor response to the disadvantages of postoperative morbidity and worse anorectal functional outcomes, when compared to observation alone. It has been our practice to only consider local excision among selected patients with incomplete clinical response as a definitive treatment strategy.

N. A considerable number of patients with complete regression of the primary cancer after CRT may still harbor residual adenomas at the site of the primary rectal cancer. These lesions usually harbor high grade dysplasia adenomatous tissue and may be more resistant to CRT than we expected. Full-thickness excision of these lesions provides appropriate management of the adenoma in addition to accurate assessment of primary cancer response within the rectal wall to CRT of these patients and should be the preferred initial treatment alternative.

O. When a non-operative strategy for cCR in rectal cancer is considered, a relatively intensive follow-up is required. Patients should be encouraged to adhere to this strict follow-up program in order to allow early recognition of any local or systemic recurrence and therefore, increasing the chance of a successful

salvage treatment. After initial assessment of response confirming a cCR, visits should be performed every 1–2 months during the first year, every 3 months during the second year and every 6 months thereafter. Digital rectal examination (DRE), proctoscopy and CEA level determination are recommended for all visits. Timing for radiological assessment during follow-up has not yet been standardized. Routine MR for the assessment of the rectal wall, mesorectum and pelvic nodes every 6 months for the first 2 years and yearly thereafter has been our practice.

P. Patients managed non-operatively under the WW strategy were originally reported to have similar long-term oncological outcomes to patients with complete pathological response after radical surgery. These findings further support the idea that patients with a cCR may be spared from the surgical morbidity and mortality of radical surgery with no oncological compromise and improved colostomy-free survival. In addition, functional outcomes of patients managed non-operatively not only appear to be better than radical surgery but also to other organ-preserving strategies (transanal local excision).

Q. Local recurrences after this treatment strategy are still a concern and may develop at any time during follow-up. The majority of local recurrences seems to develop within the first 12 months of follow-up and may represent limitations in accurate identification of microscopic residual disease among "apparent" complete clinical responders. For these reasons, these "early recurrences" developing within the initial 12 months of follow-up have been called "early regrowths" instead. Still, close and strict follow-up may allow early detection of regrowths leading to identical oncological outcomes to patients with incomplete clinical response immediately after 8–12 weeks from CRT completion. However, patients with local regrowths appear to be at higher risk for the development of systemic recurrences when compared to patients with no local regrowth.

R. Local recurrences (late and early regrowths) are usually amenable to salvage therapies, often allowing sphincter preservation and are associated with excellent long-term local disease control.

S. Considering that the rate of complete clinical or pathological response was historically <30% of patients across most of the studies, one could assume that this treatment strategy could benefit a rather limited proportion of patients with rectal cancer. However, the observation of increased rates of complete response (clinical or pathological) using regimens with consolidation chemotherapy, increased primary RT boost doses and with the inclusion of earlier stages of disease (cT2N0 otherwise candidates for ultra-low resections or APRs) may result in over 50% that may ultimately avoid surgical resection.

T. Patients with a complete clinical or pathological response to CRT are still at risk for developing systemic recurrences. There is insufficient data to support the routine use for adjuvant chemotherapy among these patients. However, with the increased use of regimens with consolidation chemotherapy in association with RT, patients may ultimately have received almost a complete course of adjuvant chemotherapy by the time neoadjuvant therapy has been completed and prior to any definitive surgical or non-surgical management.

U. Several studies have focused on the search for predictive features on pre-treatment biopsies that could possibly identify complete responders to neoadjuvant CRT prior to neoadjuvant treatment initiation. However, gene expression signatures have failed to provide clinically useful and reproducible information to accurately identify patients that ultimately will develop complete tumor regression and/or will avoid definitive surgical management. The presence of significant intratumoral heterogeneity may have contributed to these findings, as small biopsy samples may ultimately not be representative of the entirety of the primary rectal cancer, and therefore insufficient to provide accurate prediction of response.

Figure 41.1 illustrates treatment protocol for rectal cancer.

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42 Rectal Conditions: Rectal Cancer—Postoperative Surveillance

Daniel I. Chu and Gregory D. Kennedy

Refer to Algorithm in Fig. 42.1

A. Postoperative surveillance for rectal cancer involves four modalities: the clinical exam, laboratory tests, endoscopy and imaging. These modalities are also used in postoperative surveillance for colon cancer. The goals of surveillance are (1) to detect recurrent disease that may be potentially resectable and (2) to identify and remove metachronous lesions at an early stage. Compared to colon cancer, rectal cancer is at significantly higher-risk for local-regional and distant recurrence with estimates ranging from 5–15%. Studies show that 95% of recurrences, however, occur within 5-years after surgical resection. Surveillance is therefore uniformly recommended up to 5-years post-resection. Controversy remains, however, on *how* best to coordinate surveillance modalities. Certain conditions, such as locally-advanced rectal cancer, may require higher intensity surveillance while others, such as a well-localized stage 1 rectal cancer, might only require low-intensity surveillance. Future research is needed to clarify these details but the current surveillance algorithm(s) allow for some individualization of these decisions.

B. Surveillance begins with the clinical exam. The goal is to identify new symptoms such as bleeding, pain, or constipation using the history/physical examination which may prompt further testing. The National Comprehensive Cancer Network (NCCN) Guidelines currently recommend H&Ps every 3–6 months for the first 2-years and every 6 months for the remainder 3 years presuming no positive findings for more advanced rectal cancers (stage 2–4). Studies have suggested that a symptoms-based approach to further testing (waiting until symptoms develop before directed testing) does not result in a significant survival disadvantage compared to more intensive surveillance strategies. Patients undergoing symptoms-based surveillance did, however, undergo fewer curative-intent surgeries compared to more intensively surveilled patients. A recent meta-analyses of 11 randomized-control trials (RCTs) favored intensive surveillance by observing improved overall survival, shorter time to detection of asymptomatic recurrent disease and more curative-intent surgeries. Cancer-specific survival, however, was not significantly different for patients undergoing intensive or non-intensive surveillance. Until further studies clarify these controversies, H&Ps remain a

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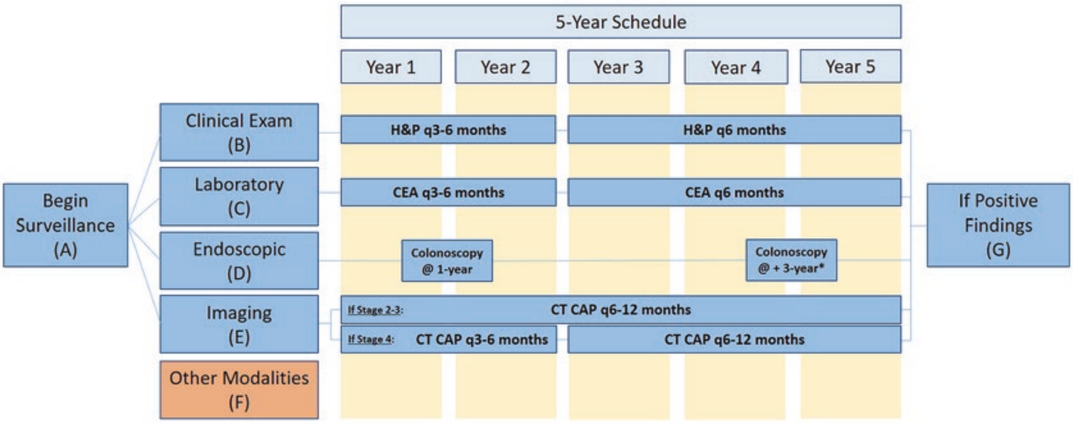

Fig. 42.1 Recommended algorithm for postoperative surveillance for rectal cancer. Surveillance begins after surgical staging (A) and uses the clinical exam (B), laboratory studies (C), endoscopic tests (D) and imaging (E). Other modalities (F) such as PET/CT and FIT/fecal DNA testing are not recommended in primary surveillance strategies. If surveillance reveals a positive finding(s), then further workup is necessary (G). *Additional colonoscopies recommended at 5-year intervals if no abnormal findings; *CAP* chest abdomen pelvis

constant on all surveillance recommendations and are a reasonable, low-cost start to any surveillance strategy.

C. Laboratory studies used in rectal cancer surveillance currently focus on measuring the tumor marker carcinoembryonic antigen (CEA). An elevation in CEA level, compared to a baseline pre-treatment measurement, warrants further investigation for recurrent and metastatic disease. The frequency of post-resection CEA measurements parallels the post-surveillance H&P schedule: every 3–6 months for the first 2-years and then every 6-months for the remainder 3-years for stage 2–4 rectal cancers (5). Studies support the benefits of frequent CEA testing including earlier detection of recurrent disease and more opportunities for curative-intent surgery.

D. Endoscopic surveillance includes colonoscopy and proctoscopy. The primary goal of colonoscopic surveillance is to detect and remove metachronous polyps as colorectal cancer patients are at higher-risk for second colorectal cancers. For all stages of rectal cancer, the NCCN and US Multi-Society Task Force recommend **colonoscopy** at 1-year post-resection to evaluate for recurrent or metachronous disease. If no colonoscopy was performed before surgery, then a closer follow-up colonoscopy is recommended 3–6 months after surgery. If the 1-year colonoscopy is normal, then the next recommended colonoscopy is not required for an additional 3 years. If the 3-year colonoscopy is normal, then subsequent colonoscopies should occur at 5-year intervals. If at any point a high-risk adenoma such as a villous or high-grade dysplastic lesion or a polyp >1 cm is detected and removed, follow-up colonoscopies should be obtained at annual intervals or at recommended polyp surveillance intervals. The American Society of Clinical Oncology (ASCO) and Cancer Care Ontario (CCO) Guidelines differ slightly and recommend colonoscopies at 1-year post-resection and then every 5-years as dictated by findings. **Proctoscopy** was previously included in standard post-resection surveillance to evaluate for low anastomotic recurrence, but the NCCN removed this recommendation in 2015 due to the rare incidence of isolated local recurrences. Proctoscopy is recommended, however, for endoscopic surveillance after transanal excisions of rectal cancers.

E. Radiographic imaging is a critical piece of post-treatment rectal cancer surveillance. Computer tomography (CT) is most familiar to clinical practice and the cornerstone of this surveillance algorithm. The primary goal of a CT chest, abdomen and pelvis (CAP) with IV contrast is to detect metastatic disease in the lungs and liver and to determine their potential resectability. The NCCN recommends a CT surveillance schedule that follows a pattern identical to H&P and CEA levels but differs by staging. For stage 2–3 rectal cancer, CT CAPs should be obtained every 6–12 months for 5 years total. For stage 4 rectal cancer, CT CAPs should be obtained every 3–6 months for the first 2 years before spacing out to every 6–12 months for the remaining 3 years. The ASCO/CCO guidelines differ slightly with a less-intensive schedule and recommend CT scans annually for 3-years post-resection.

F. Other surveillance modalities such as positron-emission tomography (PET) are not recommended in primary surveillance strategies. PET may be most useful, however, after detection of equivocal lesions or in the setting of an elevated CEA with negative, high-quality CT scans. Fecal immunochemical tests (FIT) and fecal DNA testing are also not recommended as surveillance tools due to insufficient evidence at this time supporting their utility for post-resection surveillance.

G. When surveillance modalities detect possible recurrent or new disease the patient requires a full staging workup. The available modalities remain the same. For elevated CEA levels, the workup includes H&P, endoscopic and radiographic studies. For isolated pelvic recurrence or metachronous lesions, the treatment will depend on whether the lesion is resectable versus non-resectable. It is clear that a multidisciplinary approach to recurrent rectal cancer is necessary. However, a full discussion of the management of this complicated situation is beyond the scope of this chapter.

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43 Recurrent Rectal Cancer

Ian White and Shmuel Avital

Introduction

Until late in the twenty-first century, the local recurrence rate after rectal cancer surgery was approximately in excess of 20% and occasionally as high as 50%. With the introduction of the total mesorectal excision (TME) surgical technique by Professor Bill Heald in England, as well as the use of neoadjuvant chemo-radiotherapy in Northern Europe (The Dutch trial), the local recurrence rate significantly decreased to below 5%.

Metastatic disease is most commonly seen in the liver and lungs, and aggressive radical surgery is well accepted and has shown to be successful in increasing survival. Local recurrent disease is defined as the recurrence of adenocarcinoma in the pelvis following previous rectal cancer surgery. Treatment involves radical surgery and is often very complicated. Cure rates have improved in recent years (50% between 2005 and 2012 compared to 32% between 1988 and 1996) with multimodal therapy and dedicated teams.

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In this chapter, we will discuss the factors associated with local recurrence, its detection, as well as metastases and their treatment options and prognosis.

Risk Factors Associated with Local Recurrence

Multiple risk factors have been identified and include tumor-specific features, patient-related issues, surgical technique, and institutional/departmental knowledge and multidisciplinary expertise.

Advanced tumor stage, poor differentiation, and lymphovascular and perineural invasion as well as lower, bulkier, macroscopically infiltrating tumors are all associated risk factors. Male patients with narrower, longer pelvises and those who are obese patients have been linked to worse outcomes, most probably due to a more demanding surgical resectability. Surgeon experience has also shown to be a prognostic factor with higher caseloads in higher volume centres (over 10–12 rectal cancer cases/year) and a higher frequency of sphincter saving procedures and properly administered neoadjuvant therapy resulting in lower recurrence rates. Such examples are the recurrence rates of 4% in the higher volume centers versus 10% in the lower volume centers, as reported in the Stockholm trial.

Today's principles of sharp TME dissection should be practiced by all surgeons, as well as

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knowledge of proper distal and proximal margins and, most importantly, the circumferential resection margin (CRM), which has been proven as perhaps the most important factor predictive of local recurrence and survival.

Lateral clearance of <1 mm (positive CRM) results in a significantly higher likelihood for recurrence (3.5 times) and significantly reduced survival (5-year survival: 29% vs. 72%, positive vs. negative CRM).

Conversely, in the early era of TME, abdominoperineal resection (APR) was associated with higher recurrence rates, until the issue of "coning" in lower tumors was overcome and a return to traditional APR (Fig. 43.1), leading to a lower risk of CRM positivity and rectal/tumor perforation.

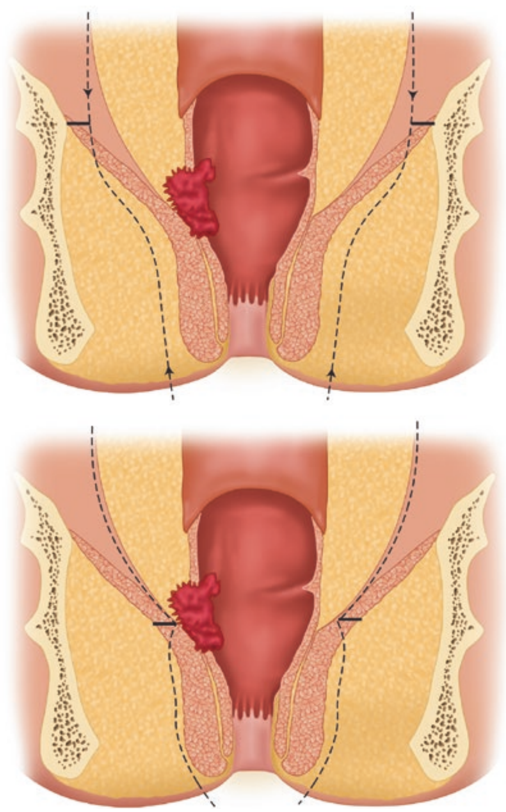

Fig. 43.1 Extralevator APR versus conventional APR. Right side dotted line shows dissection close to the tumour leading to increased positive CRM and tumour/rectal perforation as opposed to dissection on left hand side leading to clearer margins and decreased local recurrence

The index surgery has a bearing on the type of recurrence and the subsequent ability for salvage. As compared to sphincter sparing surgery followed by anastomotic and perianastomotic recurrences, recurrences following APR are in a significantly more violated pelvis and across much wider areas. Ironically, in procedures with insufficient TME, salvage surgery is more successful, most likely due to the time taken to reach non-resectable tissue and the surgeon's ability to remove the recurrence in the mesorectum. Recurrence at the anastomosis or perianastomotic tissue has a more favorable outcome as it is easier to diagnose following digital rectal examination, endoscopy, and biopsy; symptoms manifest much earlier. Following APR, the pelvic tissue has been more extensively violated leading to a higher probability of sidewall and pelvic infiltration, making curative surgical treatment more challenging.

Local recurrence may also be noted following with or without local excision, pre and/or or post-operative chemoradiotherapy, and/o radiotherapy.

Furthermore, local recurrence may be noted after initially successfully complete response and "wait and watch" protocol. Early publications have shown excellent salvage surgery rates if a re-growth diagnosed early and the appropriate surgery is performed. The concept is that if surgery (TME) for a re-growth is immediately performed, survival rates should be comparable to rates after index surgery.

Refer to Algorithm in Fig. 43.2

Follow-up and Initial Assessment

In order to diagnose both local and distal recurrence, follow-up must be regimented and proven to be effective. Multiple studies have shown the importance of follow-up, especially within the first 2 years post surgery/treatment. There is obvious diversity among institutions around the world; Table 43.1 summarizes the most recent recommendations based on individual international organisations.

Pelvic recurrence is a complicated oncological, surgical, and multidisciplinary entity; sal-

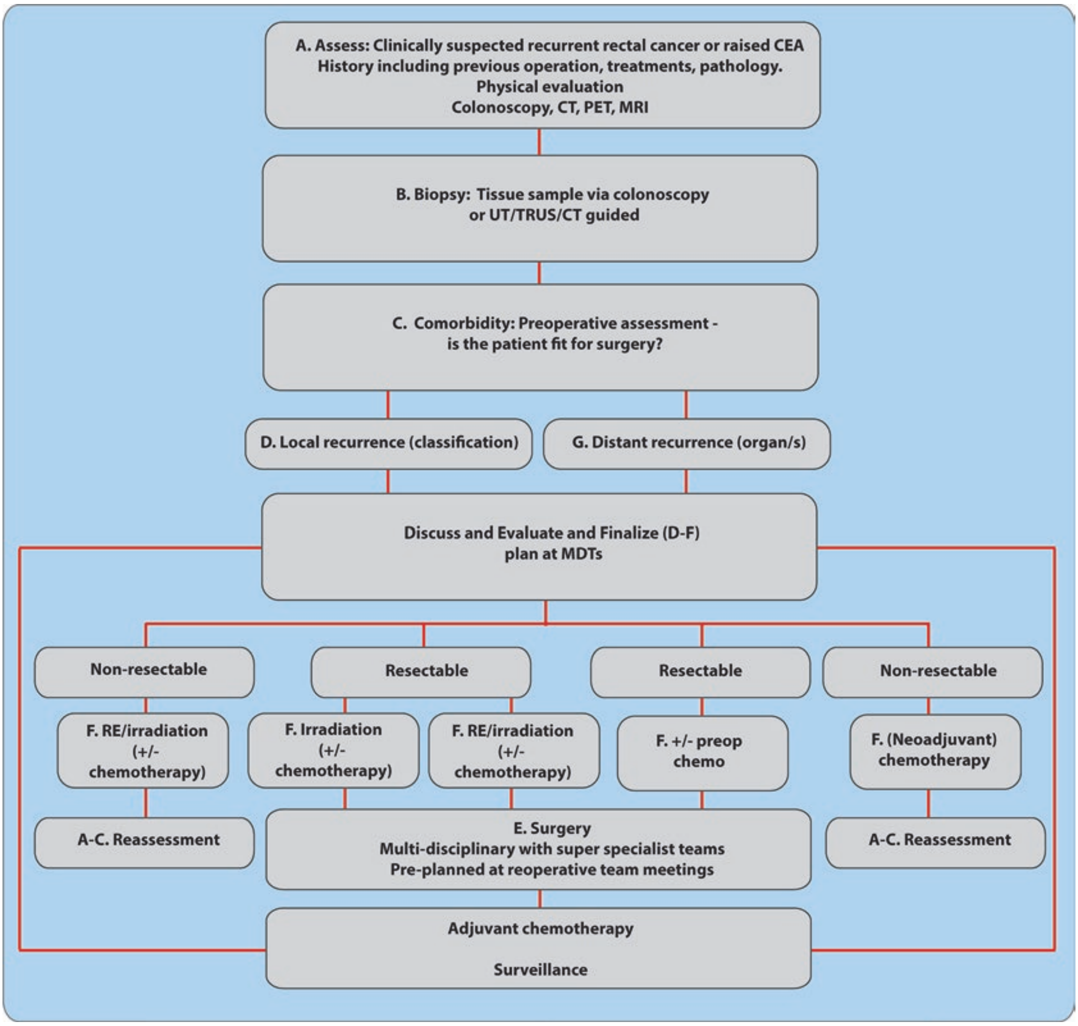

Fig. 43.2 Algorithm for management of recurrent rectal cancer

vage therapy offers the only potential for cure and preservation of quality of life. It is not surprising that, with the variation of access to specialist centres and the variety of treatment options worldwide, there is a wide range in outcomes. Median survival ranges from 22 to 60 months, 3-year local control rates range between 26% and 100%, and the 5-year distant failure rates range from 9% to 68%. Some confounders in these variable outcomes include heterogeneity of disease, previous therapies, and underlying tumor biology.

If local recurrence is suspected, further investigation is warranted. Often, the first suspicious symptom is either a clinically-related complaint or an increased CEA. Bleeding, pain, or obstructive symptoms are the most common complaints. Although CEA represents a glycoprotein oncofetal tumor associated antigen being expressed by more than 90% of colorectal adenocarcinomas, it is not increased in the serum of more than 90% of patients with primary rectal cancer. As a marker, it is used to monitor treated patients for recurrent disease. Sensitivity and specificity of CEA as a marker during follow-up ranges from 43% to 98% and 70% to 90%, respectively. Both its absolute value and increase over time should prompt further investigations.

Table 43.1 Published colorectal surveillance guidelines

	History and physical	CT (chest/abdomen/pelvis)	CEA	Colonoscopy
ASCO (Stage II/III)	Every 3–6 months × 3 years; every 6 months at years 4 and 5	Annually × 3 years if high risk	Every 3 months for at least 3 years	At 3 years and then every 5 years thereafter
NCCN (Stage I–III)	Every 3–6 months × 2 years; every 6 months in years 3–5	Annually for up to 5 years, especially if high risk	Every 3–6 months × 2 years; every 6 months in years 3–5	At years 1 and 4, then every 5 years
ASCRS (Stage I–III)	At least every 4 months for 2 years	None	At least every 4 months for 2 years	Every 3 years
UK (Stage I–III)	None	CT of abdomen and pelvis only, once within 2 years	None	Every 5 years

ASCO American Society of Clinical Oncology. *ASCRS* American Society of Colon and Rectal Cancer Surgeons. *CEA* carcinoembryonic antigen, *NCCN* National Comprehensive Cancer Network, *UK* United Kingdom 2010 Guideline. (Modified from Optimal post-treatment surveillance in cancer survivors: is more really better? Shah M, Denlinger CS. Oncology (Williston Park). 2015 Apr;29(4):230–40)

Currently, CT scan, fluoro-deoxy-glucose positron emission tomography (FDG)-PET/CT scan, MRI, and a host of other diagnostic tools are used to further evaluate and identify recurrences. CT correctly diagnoses recurrence in approximately 76% of patients, although there are a significant number of false positives. FDG-PET scan is an accurate modality for detecting pelvic recurrence and may have advantages over CT and MRI scan in differentiating scar tissue from viable tumor. The reported accuracy ranges from 74% to 96%. Nevertheless, it has certain limitations including inability to detect small lesions, mucinous tumors, and small positive lymph nodes. MRI is an excellent modality for detection and is highly recommended due to its excellent soft-tissue resolution. Distal intra-luminal recurrence can be identified by rectal digital examination and more proximal recurrence by endoscopy.

A–C.

Figure 43.2 is the algorithm we have developed for the assessment of retreatment of recurrent rectal cancer. The first step (A) is assessment, which occurs either naturally during follow-up or out of necessity if clinically warranted.

When assessment is completed, including further radiology if a recurrence is located, either locally, then a tissue biopsy is needed (B). Different modalities can be employed depending on location.

Finally, the patient must be assessed for fitness for surgery, including functional status and quality of life (C). Assessment by other specialists including for example a cardiologist, neurologist or lung specialist with echocardiogram, stress test, carotid Doppler or lung function tests may be needed.

D. Local Recurrence (See Fig. 43.2)

Classification of Local Recurrence

Many authors have attempted to classify local recurrence using various methods, with anatomical location being the most popular. Although there are a variety of methods, most are similar to a Netherlands group that suggested the following according to imaging: (1) presacral: predominantly midline, in contact with the sacral bone, (2) posterolateral: laterally located, near to or invading the piriformis muscle, in contact with the sacral bone, (3) (antero)lateral: laterally located, in association with anterior organs or along the iliac vessels or in the obturator lymph node compartment, (4) anterior: predominantly midline, involving bladder, uterus, vagina, seminal vesicles, or prostate, (5) anastomotic: midline, after low anterior resection, low Hartmann procedure, or local excision, at the staple line, (6)

perineal: midline, perineum, or anal sphincter complex with surrounding perianal and ischiorectal space, or (7) other location. Their results, subsequently verified by others, showed a direct correlation with the site of recurrence with R0 resections achieved in 54% of the patients, and 5-year cancer-specific survival was 40.5%. The worst outcomes were seen in presacral locally recurrent rectal cancer (LRRC), with only 28% complete resections and 19% 5-year survival (P = 0.03 vs. other subsites). Anastomotic LRRC resulted in the most favorable outcomes, with 77% R0 resections and 60% 5-year survival (P = 0.04). Generally, if a complete resection was achieved, survival improved, except in postero-lateral LRRC. Local re-recurrence and metastasis rate were lowest in anastomotic LRRC.

Although TME has dramatically improved management of rectal cancer, its popularity decreases the likelihood that a recurrent neoplasm will remain confined to a specific compartment due to the absence of visceral rectal fascia.

An alternate system used at the Mayo Clinic classified these tumours based on the presence of symptoms, with a particular focus on pain, as well as the degree of fixation. Figure 43.3 shows an example of the classification of locally recurrent rectal cancer.

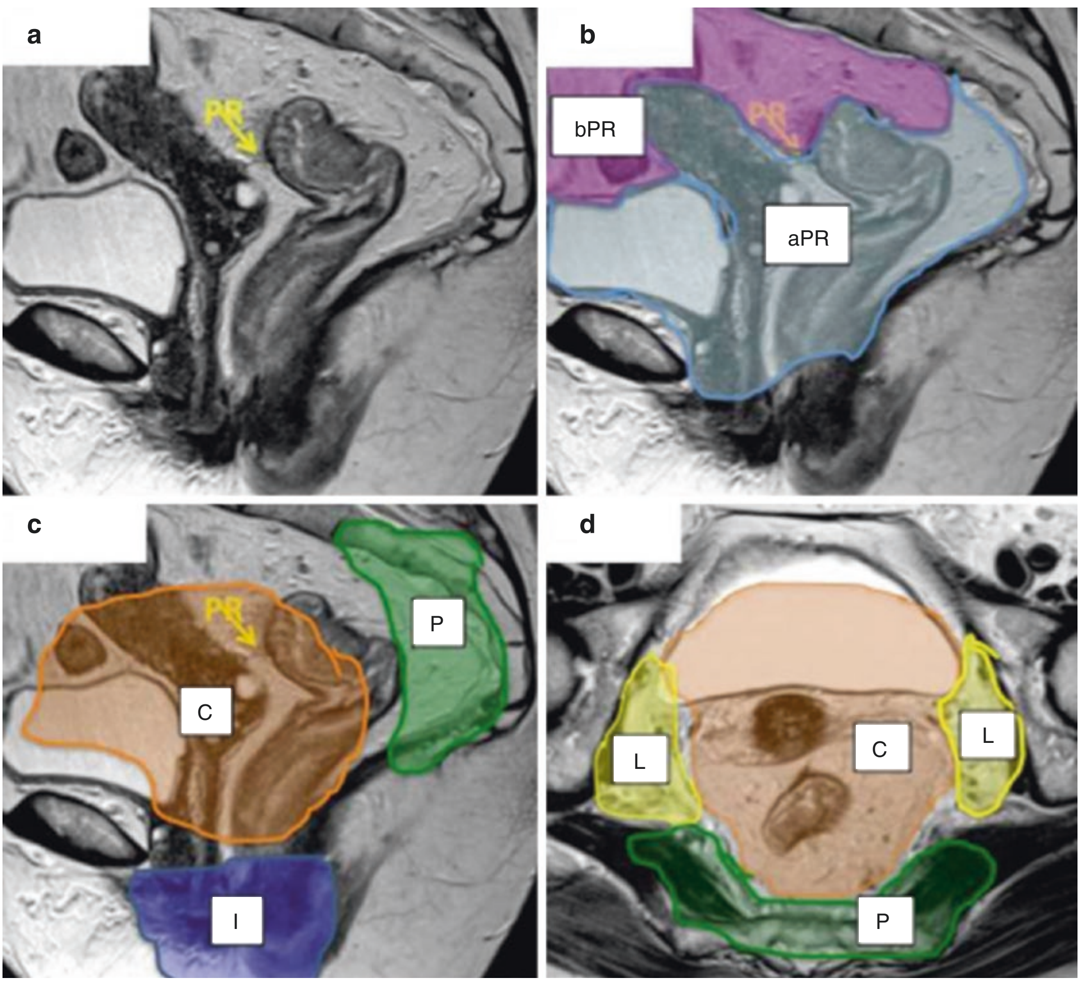

Fig. 43.3 Classification of locally recurrent rectal cancer. The pelvis can be divided into seven compartments: (**a**) peritoneal reflection (PR); (**b**) above PR (aPR), below PR (bPR); (**c**, **d**) central (C), posterior (P), lateral (L), inferior (!) (www.aibolita.com)

E. Evaluation and Planning

Following histological confirmation, anatomical assessment and the condition of the patient, a multidisciplinary evaluation, including all specialties involved in diagnosis, surgery, and oncological treatment, should evaluate curative intent and the best possible treatment plan. This step cannot be overemphasized as it is vital to the success of surgery and all other treatments. It is this multi-team approach of planning and working as a unit that increases the ability to reach R0 resection and thus the most optimal disease-free survival rates. This has been demonstrated in one specialized center in the UK that found that a minimum of 14 cases was required to acquire the necessary experience to optimize overall perioperative complication rate associated with exenterative pelvic surgery. **Group decisions are made** at the MDT regarding resectability, cure, pre-operative neoadjuvant radio-chemotherapy, and palliative care.

Patients must be extensively pre-operatively counselled due to the high morbidity and risk of complications, including significant blood loss, long intensive care and overall hospital stay, sepsis, abscess, fistulas, wound and perineal infection and dehiscence, urinary infection, prolonged bowel ileus, and obstruction, re-operation, and re-admission. The mortality risk is quoted as <5%.

F. Surgical Treatment

Although multimodal treatment is usually required, surgery is usually the only solution that achieves cure. Approximately 50% of local recurrences are amenable to R0 resection; palliative surgery may help significantly decrease pain, bleeding, obstruction, and tenesmus. These issues must all be discussed and planned in advance.

For curative surgery, as stated earlier, pre-planning must involve all the necessary teams including the anaesthetist. Surgery should commence only after scans have been completed and assessed, biopsy achieved, and resectability confirmed. Moreover, reconstruction must be possible if resection is to be considered, which often involves a highly skilled plastic surgery team with previous experience in multiple free and rotation flaps to enable rebuilding of the perineum. Additional team members include gynecology, urology, neurosurgery, spine surgery, or vascular surgery. Ureteric catheters are a very useful adjunct.

Absolute contraindications to resectability include:

- Poor performance status/medically unfit patients
- Bilateral sciatic nerve involvement
- Circumferential bone involvement
- Frozen pelvis

Relative contraindications include:

- Extension of tumor through the sciatic notch
- Encasement of external iliac vessels—requiring en bloc resection and/or reconstruction of external iliac vessels
- High sacral involvement—resection above the S2/3 junction can be performed with suitable surgical expertise and equipment in superspecialist centres
- Unresectable distant metastases

Superspecialist surgical techniques (such as high sacrectomy—S2 and above) should only be offered in surgical units with appropriate multidisciplinary expertise. Most commonly, gynaecologists will be needed for complete en bloc excision of the uterus, ovaries, and closure of the vagina after removal, and urologists for creation of an ileal conduit although there is a wide range of bladder reconstruction options.

Every surgical procedure must begin with explorative laparoscopy or laparotomy. Peritoneal seeding, unexpected liver metastases, and invasion of para-aortic lymph nodes are generally contraindications to continue. It is suggested that injury to critical structures should be avoided until resectability has been proven.

The majority of patients will have a permanent end colostomy, although very highly motivated patients with favourable pathology may be able to undergo reconstruction with a coloanal

anastomosis. If there is the possibility of postoperative radiotherapy, then clips should be placed at the area in question.

G. Radio-Chemotherapy

- Radiotherapy—The majority of patients have either had neoadjuvant radiotherapy before their original surgery or prior to surgery for local recurrence. However, an additional 30–40 Gy can be administered after an R1 or R2 resection, although all attempts to avoid the small bowel should be undertaken.
- Chemotherapy—Local relapse is a precursor of distant metastases in about 50% of patients; therefore chemotherapy is recommended as an important treatment component.

Carbon-Ion Radiation (CIRT)

Carbon-Ion Radiation (CIRT) offers unique physical and biological advantages over conventional radiation, with the proffered advantage of improved dose localization and delivery to the tumor while minimizing surrounding tissue damage. Its advantage is high linear energy transfer, inducing increased double-strand breaks in DNA structures, causing irreversible cell damage independently of cell cycle or oxygenation. The literature has shown CIRT to be effective with complete and partial response in approximately 40% with symptomatic response, most often improvement in pain, maintained in over 80% at 1 year. Yamada et al. published 5-year local control and survival rates at 88% and 59%, respectively. The long-term safety aspects are still under surveillance but as an alternative to surgery or when surgery is not a possibility, CIRT offers much lower morbidity and mortality rates.

H. Distant Recurrence (See Fig. 43.2 and Chap. 40)

Surgical resection has the best prognosis for metastases discovered during follow-up after primary treatment for rectal cancer. The approach is similar to all metastases with the principle of achieving R0 from the target organ. The most commonly affected organs are the liver and lungs, followed by the abdominal cavity (peritoneum) and other organs. Pelvic and sacral bone involvement is considered a local recurrence.

Liver or lung metastases have the best results. If the lesions are deemed resectable, the patient should be referred to a thoracic and/or hepatobiliary surgeon.

The criteria for resection of pulmonary metastases were first described by Thomford in 1965 and although there has been advancement in recent years, there are still no standardized indications. One set of criteria is unilateral or bilateral resectable lung lesions, no local recurrence of primary lesions, no evidence of extrapulmonary metastases except for resectable hepatic metastases, and adequate cardiorespiratory function for complete resection of all pulmonary lesions. Using these criteria, the 5-year survival after pulmonary resection is reportedly 45.5%. The liver is the most frequent site for metastases from colorectal cancer and, if present before or synchronously with pulmonary metastases, there is no effect on patient survival if an R0 resection can be achieved. Many authors have shown favorable survival for patients with solitary pulmonary metastasis and poor prognosis for patients with two or more pulmonary metastases. Moreover, treatment that includes both hepatic and pulmonary resections has been shown to result in survival and safety outcomes comparable to isolated hepatic or pulmonary resections.

In current studies, multivariate analyses for time after initial metastasectomy revealed that the primary site, the number of hepatic tumors, and simultaneous or sequential metastases were independent prognostic factors. These prognostic factors may be good indicators for the selection of candidates for intensive postoperative adjuvant therapy.

Overall, the rates of hepatic and/or pulmonary resection for colorectal metastases have increased during the last decade, which could be attributable in part to advances in surgical techniques, including the adoption of staged or repeated resection of hepatic or pulmonary metastases.

Another contributing factor may be preoperative systemic therapy consisting of neoadjuvant therapy for initially resectable disease and conversion therapy for initially unresectable disease. Considering these advances, hepatic and/or pulmonary resection should be standard, at least in high-volume centers, as long as R0 resection can be achieved while maintaining functional residual liver and/or lung activity.

For hepatic metastases, radiofrequency ablation (RFA) has been championed as a less invasive and less aggressive treatment option compared to resection. In a Korean study from 2016 of patients with solitary hepatic metastases of ≤3 cm, the marginal recurrence was higher in the RFA group (3% vs. 17.2%), although re-RFA was performed to achieve comparable recurrence rates (3% vs. 5.2%, P = 0.662). The recurrence-free survival rate was not different between the resection and RFA groups (52.4% vs. 53.4%, P = 0.491). Surgical resection showed higher recurrence free survival (RFS). However, the RFS rate in patients with a solitary hepatic metastasis of ≤3 cm was similar between the resection and RFA groups.

Traditionally, consensus in the oncology community was that patients with peritoneal carcinomatosis of colorectal origin were incurable. Neither systemic chemotherapy nor intraperitoneal chemotherapy alone had any significant impact on survival. Recently, there has been increased interest in re-examining the management of peritoneal metastatic disease, and in combining cytoreductive surgery and hyperthermic intraperitoneal chemotherapy. A randomized trial by a Dutch group demonstrated superior survival with this combined approach over the traditional 5-fluorouracil-based systemic chemotherapy for peritoneal carcinomatosis of colorectal cancer. Moreover, with proper patient selection, minimal morbidity can be achieved, with good overall survival and prolonged disease-free survival. Major perioperative complications and mortality is improving markedly and therefore a combined approach can be a feasible treatment option for the traditionally inoperable recurrent rectal cancer patient with peritoneal metastasis.

Conclusion

In summary, recurrent rectal cancer is a highly difficult disease to treat with a high morbidity and mortality rate. R0 resection is currently the only cure, with palliative relief a second option. Anastomotic local recurrence has higher cure rates than does pelvic recurrence and MDTs optimize the results of salvage surgery.

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Locally Advanced Rectal Cancer

44

Daniel W. Nelson and Anton J. Bilchik

Refer to Algorithm in Fig. 44.1

A. Colorectal cancer represents the fourth most frequently diagnosed cancer in the United States, but the second or third leading cause of cancer-related death. According to the National Cancer Institute's Surveillance, Epidemiology and End Results Program, of the 145,600 new cases of colorectal cancer estimated to occur in 2019, nearly 30% will be primary rectal cancer. Over the last 40 years, the overall incidence rate of colorectal cancer has been declining. Furthermore, 5-year survival rates which were once 48% for rectal cancer in 1975 had risen by 20% by 2019. This progress can be attributed to earlier diagnosis through endoscopic screening programs, standardized surgical techniques, and more effective neoadjuvant/adjuvant therapies.

Locally advanced rectal cancer includes stage II and III disease (Table 44.1 and Fig. 44.2). These tumors invade through the muscularis propria into pericolorectal tissues (T3), penetrate to the surface of visceral peritoneum (T4a), directly invade or adhere to other organs or structures (T4b), or are accompanied by evidence of locoregional nodal disease (N1-2). Whereas patients with T1-2N0M0 rectal cancer can achieve 90% 5-year survival rates with surgery alone, those with T3-4N1-2 disease have local recurrence rates ranging from 30–65% with surgery alone. This chapter focuses on the workup, staging and management of locally advanced rectal adenocarcinoma (stage II/III).

From an anatomic perspective, the rectum is defined as the distal 12–15 cm of bowel leading to the anal verge. From the surgeon's viewpoint, the lower limit of the rectum is typically regarded as the top of the anorectal ring whereas the upper limit of the rectum is represented by where the taeniae splay and can no longer be distinctly identified, at the level of the sacral promontory. The rectum is subdivided into three separate 5 cm sections: upper, middle and lower rectum. These subdivisions are often based on anatomical folds of the rectum known as the valves of Houston. This anatomy has important prognostic and therapeutic implications. For one, the lymphatics of the upper rectum drain via the portal venous system similar to the colon, whereas lymphatics of the middle and lower rectum drain into both the portal and systemic venous circulation. This circulating pattern explains why the incidence of lung metastasis

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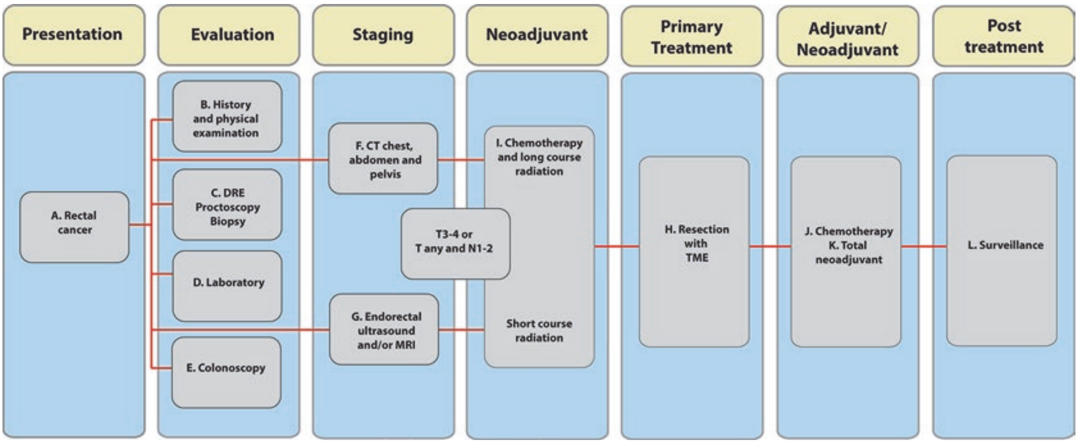

Fig. 44.1 Algorithm for the workup, staging and treatment of locally advanced rectal cancer. *DRE* digital rectal examination

Table 44.1 AJCC (Eighth edition) staging systems for rectal cancer

AJCC	
Tumor	
T1	Tumor invades submucosa
T2	Tumor invades muscularis propria
T3	Tumor invades through the muscularis propria into pericolorectal tissues
T4a	Tumor invades through the visceral peritoneum
T4b	Tumor directly invades or adheres to adjacent organs or structures
Nodes	
N0	No regional lymph node metastasis
N1	Metastasis in 1-3 regional lymph nodes
N1a	Metastasis in 1 regional lymph node
N1b	Metastasis in 2-3 regional lymph nodes
N1c	Tumor deposit(s) in the subserosa, mesentery, or nonperitonealized pericolic or perirectal tissues without regional nodal metastasis
N2	Metastasis in 4 or more regional lymph nodes
N2a	Metastasis in 4-6 regional lymph nodes
N2b	Metastasis in 7 or more regional lymph nodes
Metastasis	
M0	No distant metastasis
M1	Distant metastasis
M1a	Metastasis confined to 1 organ or site (e.g., liver, lung, ovary, nonregional node)
M1b	Metastases in 2 or more organs or sites
M1c	Metastasis to the peritoneal surface alone or with other organ or site
Stage	
I	T1, N0, M0
	T2, N0, M0
IIA	T3, N0, M0
IIB	T4a, N0, M0
IIC	T4b, N0, M0
IIIA	T1-T2, N1/N1c, M0
	T1, N2a, M0
IIIB	T3-T4a, N1/N1c, M0
	T2-T3, N2a, M0
	T1-T2, N2b, M0

Table 44.1 (continued)

AJCC	
IIIC	T4a, N2a, M0
	T3-T4a, N2b, M0
	T4b, N1-N2, M0
IVA	Any T, any N, M1a
IVB	Any T, any N, M1b
IVC	Any T, any N, M1c

AJCC American Join Committee on Cancer

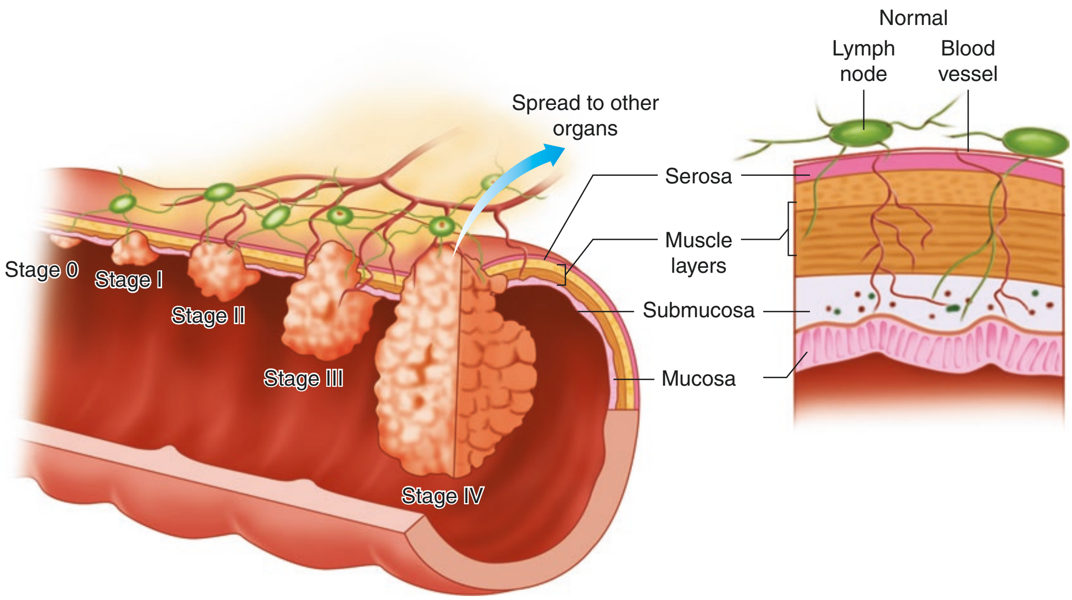

Fig. 44.2 Stages of cancer

is higher in rectal cancer compared to cancer of the colon. Because the upper third of the rectum is above the anterior peritoneal reflection and outside the bony pelvis, treatment of lesions in this region typically is similar to treatment of colon cancer: surgery, adjuvant chemotherapy when indicated, but not radiation therapy.

B. Due in large part to the success of endoscopic screening programs, patients are frequently referred to the surgeon after a diagnosis of rectal cancer has been confirmed. However, a thorough history and physical examination remains critical for determining appropriate staging investigations and planning treatment options. Occasionally, patients may be asymptomatic at presentation. More commonly, patients may note changes over time in the character or caliber of their stool or report rectal bleeding. Sensations of tenesmus, the continuous urge to evacuate, or pain with defecation are more ominous symptoms and may suggest more advanced disease, such as a large tumor or a tumor invading the anal sphincters or pelvic floor. A continence history including use of a validated incontinence score will assist in eventual surgical decisions. A complete family history is also important as this information may implicate hereditary cancer syndromes and guide further investigations for other associated pathologies.

C. The digital rectal exam (DRE) remains the cornerstone of a complete physical examination and is essential to surgical decision-making. The digital assessment provides

information regarding tumor location and its relationship to the anorectal ring. In addition, tumor mobility or degree of fixation can be assessed through manual palpation. An important adjunct to the DRE is rigid proctosigmoidoscopy. Proctoscopy allows direct visualization of the tumor and accurate measurement of its distance from the anal verge. DRE in conjunction with rigid proctosigmoidoscopy can indicate the feasibility of a sphincter-preserving operation. Biopsy may be performed at the time of proctoscopy if histopathological diagnosis has not previously been obtained.

D. Routine laboratory tests during the initial evaluation include complete blood cell counts and liver function tests as well as any other labs indicated based on patient co-morbidities. A baseline carcinoembryonic antigen (CEA) level is recommended. The primary role of CEA monitoring is to detect recurrences after treatment.

E. If not previously performed, a complete colonoscopy should be preoperatively obtained to detect synchronous polyps (up to 30% of cases) and synchronous cancers (1–3% of cases). If complete preoperative colon clearance is impossible due to an obstructing tumor or other cause, it is acceptable to plan for early postoperative evaluation within 3–6 months.

F. The most common imaging studies used in the staging assessment include computed tomography (CT), endorectal ultrasound (ERUS) and magnetic resonance imaging (MRI). Although it is not the study of choice for evaluating the extent of the primary tumor, CT remains the most common initial imaging study due in large part to its cost effectiveness and utility in assessing the patient for metastatic disease. The two most frequent sites of distant metastasis from rectal cancer include the liver and lungs. Therefore, a routine preoperative staging workup should include a CT scan with intravenous and oral contrast of the chest, abdomen and pelvis (Fig. 44.3).

Positron emission tomography (PET) and combination PET/CT are alternative imaging modalities that may be considered in the initial staging of rectal cancer, however, their role currently remains investigational. While combination PET/CT has similar diagnostic accuracy to CT alone for evaluating T-stage,

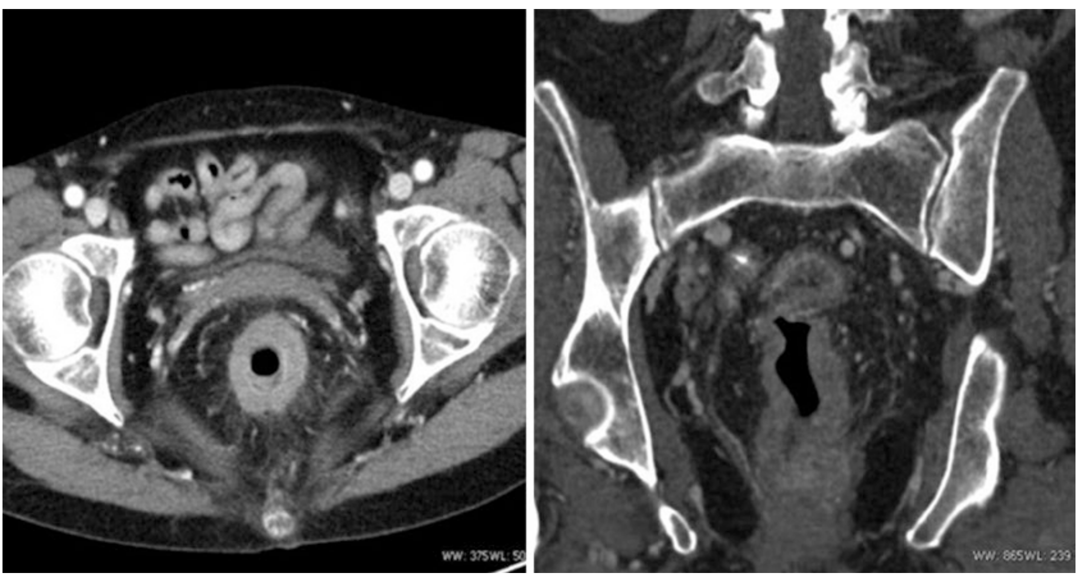

Fig. 44.3 Computed tomography image demonstrating locally advanced rectal cancer. (With permission © Springer)

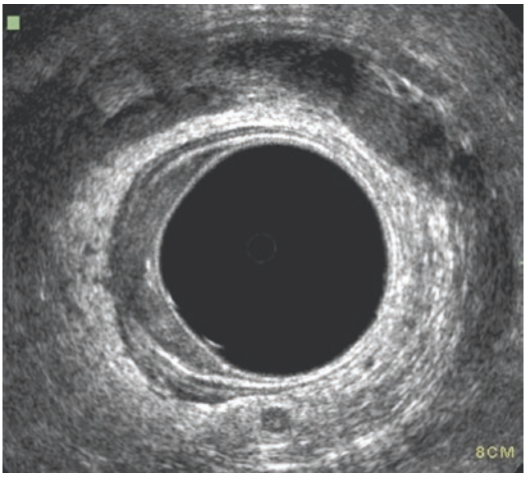

Fig. 44.4 Endorectal ultrasound image demonstrating locally advanced rectal cancer

PET/CT appears to be superior in identifying distant metastatic disease, particularly peritoneal and hepatic metastases. Conversely, PET is limited by low overall sensitivity as this modality cannot reliably differentiate malignancy from inflammatory changes.

G. ERUS and MRI can accurately assess depth of tumor invasion (T stage). Due to its ability to differentiate the layers of the rectal wall, ERUS is particularly useful for evaluating superficial, early-stage lesions (T1-2) (Fig. 44.4). Although the overall accuracy of ERUS in diagnosing T stage has been reported to be as high as 87%, it becomes less accurate when assessing more advanced lesions (T4). In such situations, MRI with endorectal or phased array coils has reported sensitivity and specificity of 100% and 86%, respectively. MRI is particularly useful for assessing tumor encroachment of the circumferential resection margin (CRM) between the rectal tumor and the mesorectal fascia (Fig. 44.5). MRI can predict CRM involvement with an accuracy of 91%. Although the exact number of millimeters (mm) is controversial, the CRM is considered positive when it is ≤1 mm.

Both ERUS and MRI may also provide information regarding locoregional nodal involvement. Nodal size is not a reliable means of diagnosing nodal involvement. Even in nodes measuring <5 mm, as many as 18% may harbor metastases. Nevertheless, with sensitivities and specificities of 67% and 78% for ERUS and 66% and 76% for MRI, respectively, these modalities represent the most accurate means for evaluating nodal basins at this time. MRI is the preferred modality.

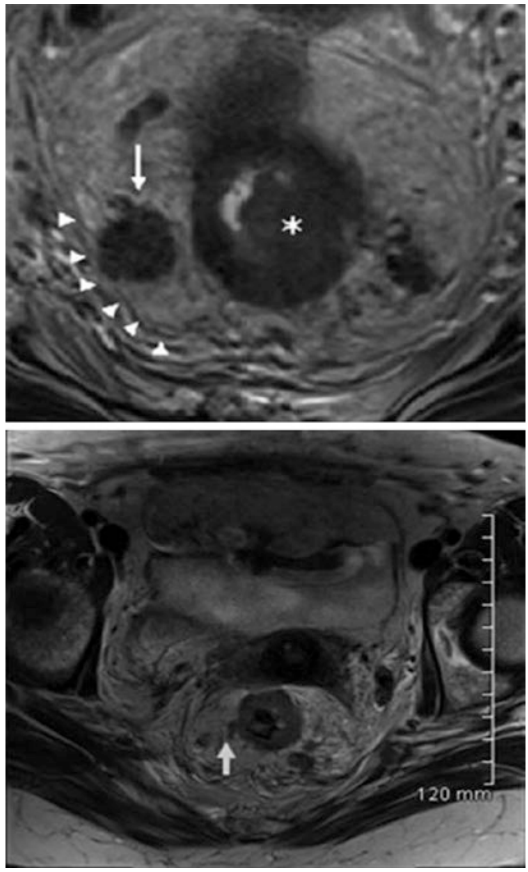

Fig. 44.5 Magnetic resonance image of locally advanced rectal cancer demonstrating the circumferential resection margin. (With permission © Springer)

H. Surgical resection of advanced rectal cancer must clear all margins (proximal, distal and radial) and remove at least 12 locoregional lymph nodes. Total mesorectal excision (TME) involves complete removal of the node-bearing mesorectum along with its

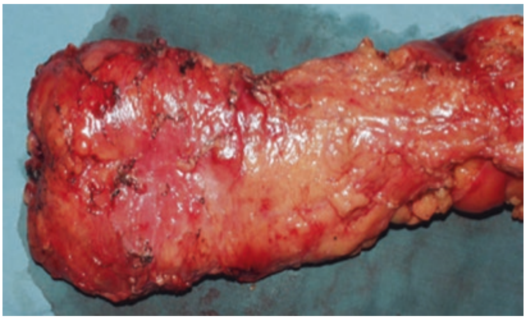

Fig. 44.6 Total mesorectal excision specimen demonstrating intact mesorectum

intact enveloping fascia (Fig. 44.6). TME requires sharp dissection in the extrafascial plane between the presacral fascia and the fascia propria of the rectum. This envelope corresponds to the CRM. TME reduces the incidence of positive radial margins by as much as 18% compared to conventional blunt dissection. This technique also preserves parasympathetic and sympathetic nerve bundles, thereby reducing rates of impotence and ejaculatory dysfunction.

Historically, proximal and distal resection margins of 5 cm were recommended. However, evidence now suggests that distal intramural spread occurs in less than 10% of cases and is rare beyond 1.5 cm from the primary tumor. As a result, a 2 cm distal margin is now considered optimal; even a 1 cm distal margin may be adequate, particularly in patients receiving preoperative neoadjuvant chemoradiation. This has allowed more patients to undergo oncologically sound, sphincter-preserving operations (low anterior resection with coloanal anastomosis). However, in those patients with evidence of direct sphincter involvement or in whom a distal 1 cm margin is unattainable, abdominal perineal resection (APR) may be recommended. Because APR alone is associated with high rates (12–30%) of positive CRM, extralevator dissection can ensure negative radial margins and thereby reduce the rate of local recurrence. During extralevator dissection, the levator ani muscles are resected en bloc with rectum and anus.

Advanced T4 tumors can extend to invade nearby pelvic organs or bony structures of the pelvis. In such cases, all or part of these organs or structures must be resected en bloc with the primary tumor. In females, anteriorly fixed lesions may require concomitant hysterectomy, vaginectomy, and/or partial or complete cystectomy. Similarly, anterior fixed lesions in males may require simultaneous prostatectomy. Posteriorly, tumors may invade the sacrum and necessitate sacrectomy. Factors associated with unresectability include circumferential tumor involvement extending into the lateral pelvic sidewall. This may be suggested preoperatively if there is evidence of bilateral ureteral obstruction. In addition, invasion of the S1 or S2 nerve roots or into the sacral bone at the level of S1 and S2 is not amenable to resection. Following total or partial pelvic exenterations, the resultant defect will require reconstruction with well-vascularized muscle flaps. Due to the complex nature of these tumors, involving surgical subspecialists from urology, gynecology, orthopedics and plastic surgery early in the preoperative planning process is essential to optimize the surgical management of these patients.

In addition to resection of tumor-negative margins, the surgical procedure should remove at least 12 lymph nodes by resecting the segmental blood supply and lymphatics up to the level of the superior rectal artery. Lymph node yield may be increased by high ligation of the inferior mesenteric artery pedicle, but ligation just inferior to the takeoff of the left colic artery is also acceptable. High ligation also has the advantage of improving mobilization of the left colon to accommodate a tension-free coloanal anastomosis.

I. In 1985, a landmark study undertaken by the Gastrointestinal Tumor Study Group (GITSG) demonstrated the efficacy of postoperative chemotherapy and radiation therapy for rectal cancer. As compared with surgery alone, adjuvant chemoradiation reduced local recurrence rates from 55% to 33%. The National Surgical Adjuvant Breast and Bowel Project (NSABP)

R-01 trial confirmed the importance of multimodality therapy, and in 1990 a National Institutes of Health (NIH) Consensus Development Conference on Adjuvant Therapy for Patients with Colon and Rectum Cancer recommended postoperative chemoradiation as standard treatment for patients with locally advanced rectal cancer.

The Swedish Rectal Cancer Trial, published in 1997, randomized patients to receive short-course radiation therapy using 5 Gy daily over 5 days without chemotherapy followed by surgery 1 week later versus surgery alone. This trial demonstrated the benefits of short-course neoadjuvant radiation with local recurrence rates of 9% versus 26% in the surgery alone cohort. Furthermore, this has been the only study to demonstrate an overall survival advantage with multimodality therapy. This study has been criticized however because patients had not undergone TME. In 2001, a randomized study conducted by the Dutch Colorectal Cancer Group found that local recurrence rate was 8.2% after TME alone but only 2.4% after short-course radiation therapy followed by TME. Based on these studies, short-course radiation therapy is advocated in Northern Europe and Scandinavia. However, in large part due to the GITSG and NSABP R-01, long-course chemoradiation therapy (conventional doses of radiation fractionated over 5 weeks to a total dose of 50.4 Gy) with concurrent administration of 5-FU based chemotherapy has been favored in North America and some European countries.

In 2004, the German Rectal Cancer Study Group demonstrated that neoadjuvant chemoradiation was more effective than postoperative chemoradiation for reducing local recurrence rates (6% vs 13%), increasing rates of sphincter-preservation, and decreasing the incidence of significant acute and long-term toxicities. Neoadjuvant use of long-course chemoradiation therapy or short-course radiation therapy followed by TME provides durable local control. Postoperative adjuvant chemoradiation remains an option for patients whose disease is understaged by preoperative imaging; reportedly as many as 22% of patients with locally advanced rectal cancer (Table 44.2).

J. Because as many as 20–25% of patients will eventually develop metastatic disease after curative resection of locally advanced rectal cancer, adjuvant chemotherapy has been used

Table 44.2 Summary of landmark randomized controlled trials in locally advanced rectal cancer

Trial	Treatment groups	TME performed?	Findings
GITSG, 1985	1. Adjuvant chemoradiation 2. Observation	No	Adjuvant chemoradiation reduces local recurrence 55% to 33%
NSABP R-01, 1988	1. Adjuvant chemotherapy 2. Adjuvant radiation 3. Observation	No	Chemotherapy improved DFS and OS compared to observation; Radiation therapy reduced local recurrence compared to observation
Swedish Trial, 1997	1. Preoperative short course radiation 2. Observation	No	Demonstrated overall survival advantage with preoperative short course radiation
Dutch Trial, 2001	1. Neoadjuvant short course radiation 2. TME	Yes	Neoadjuvant short course radiation reduced local recurrence by >50%
German Trial, 2004	1. Neoadjuvant chemoradiation 2. Adjuvant chemoradiation	Yes	Neoadjuvant chemoradiation associated with improved local control (6% vs 13% recurrence)

GITSG Gastrointestinal Tumor Study Group, *NSABP* National Surgical Adjuvant Breast and Bowel Project, *TME* total mesorectal excision, *DFS* disease-free survival, *OS* overall survival

to eradicate systemic micrometastatic disease. Although the largest trial examining the role of adjuvant chemotherapy for locally advanced rectal cancer (European Organization for Research and Treatment of Cancer [EORTC] 22921) found no significant improvement in disease-free survival or overall survival, only 43% of patients completed the full course of adjuvant chemotherapy. Despite inconclusive data, the National Comprehensive Cancer Network (NCCN) recommends adjuvant chemotherapy for all stage II and III rectal cancers regardless of final pathological results. Acceptable regimens include 6 months of combination 5FU + leucovorin or capecitabine in combination with oxaliplatin or 5FU + leucovorin or capecitabine alone.

K. In an effort to address high rates of distant metastatic disease recurrence and improve long term outcomes among patients with rectal cancer, recent trends have shifted focus of the role and timing of additional systemic treatments. Multiple trials have demonstrated promising outcomes using a total neoadjuvant approach where all planned radiation and systemic therapy are administered prior to surgery. Theoretical benefits of this approach include improved compliance, decreased treatment-related toxicity, early elimination of micrometastatic disease, greater downstaging and potential for organ preservation options, assure complete (R0) resection, and possibly allow earlier reversal of diverting stoma. Conversely, a total neoadjuvant approach may negatively impact patient performance status, potentiate risk of postoperative complications or overtreat patients that may be cured by surgery alone.

In a phase 2 trial, Garcia-Aguilar et al examined the effectiveness of the neoadjuvant approach by comparing four treatment arms stratified by the number of cycles of neoadjuvant chemotherapy following chemoradiation. Compliance was considerable with 77-82% of patients completing all therapy. Furthermore, the authors demonstrated that rates of pCR improved from 18% to 38% with increasing number of cycles of neoadjuvant chemotherapy. The Spanish GCR-3 phase II trial directly compared the total neoadjuvant approach with the traditional paradigm of neoadjuvant chemoradiation, followed by surgery and adjuvant chemotherapy. Compliance rates with a total neoadjuvant approach were 94% compared to just 57% in the adjuvant treatment group. Furthermore, the total neoadjuvant approach was associate with significant reductions in toxicity-associated adverse events (19% vs. 54%). Despite these encouraging findings, there was no difference in pCR rate between treatment arms and although not powered to detect long-term disease outcomes, 5-year disease-free survival rates were similar (62% vs. 64%) (Table 44.3).

Given promising initial results of the total neoadjuvant approach, the NCCN guidelines consider administration of 12-16 weeks of 5FU + leucovorin or capecitabine in combination with oxaliplatin followed by chemora-

Table 44.3 Summary of total neoadjuvant therapy trials in locally advanced rectal cancer

Trial	Treatment groups	Findings
Garcia-Aguilar et al., 2015	Four arms Neoadjuvant chemoradiation followed by 0, 2, 4 or 6 cycles of mFOLFOX6	Compliance 77–82% pCR rates increased by 20% with 6 cycles of mFOLFOX6
Spanish GCR-3, 2015	1. Neoadjuvant chemoradiation followed by surgery and 4 cycles of adjuvant CAPOX 2. Neoadjuvant 4 cycles of CAPOX followed by chemoradiation and surgery	Compliance 94% vs 57% in favor of TNT group TNT associated with reduced toxicity No difference in 5-Year DFS

TNT total neoadjuvant therapy, *pCR* pathologic complete response, *DFS* disease-free survival

diation and surgery an acceptable option in the treatment of locally advanced rectal cancer. Further research will be needed to elucidate long-term outcomes of this approach.

L. Surveillance after surgery includes office visits at 3–6 months for the first 2 years and then every 6 months for up to 5 years. Office visits should include complete history and physical. A rising CEA level in the postoperative period may indicate recurrence. Proctoscopy is recommended every 6 months for 3–5 years. Colonoscopy should be performed 1 year after surgery unless it was not performed preoperatively; in this case colonoscopy can be performed 3–6 months after surgery. Annual CT of the chest, abdomen and pelvis is also recommended for the first 5 years after surgery.

In summary, patients with locally advanced rectal cancer require multimodality treatment that includes neoadjuvant chemoradiation, TME, and postoperative chemotherapy. A thorough understanding of the anatomy, evaluation, staging and available treatment options is essential to formulating individualized clinical decision algorithms.

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Part V

Colonic

45 Colonic: Diverticulitis

Matthew T. Brady and Jason F. Hall

Refer to Algorithm in Fig. 45.1

Colonic diverticula are saccular outpouchings of the colon wall. While true diverticula contain all layers of the intestinal wall, diverticulosis of the colon generally refers to herniation of the mucosal, and muscularis mucosal layers of the colon. These diverticula arise from the sites at which the vasa recta penetrate the circular muscle layer of the colon wall to provide blood flow to the colonic mucosa. The sites, at which the vasa recta penetrate, are typically seen along the mesenteric borders of the anti-mesenteric taenia coli at the sites of perforating vessels. Diverticula can also arise, in the absence of a perforating vessel, at sites of pressure atrophy within the circular muscle layer. In the absence of infection and inflammation these diverticula are soft, compressible, and in free communication with the lumen of the colon.

In Western societies, the presence of diverticulosis is rare under the age of 40 years, although that risk is thought to steadily thereafter, estimated to rise between 50–70% in patients 80 years and older. While the true prevalence of diverticulosis is difficult to assess given its asymptomatic nature, post-mortem studies confirm its development is associated with increasing age. It is estimated that upwards of 25% of patients with diverticulosis will develop a complication related to their diverticular disease and 1–2% of those patients will require hospitalization.

Diverticular disease historically has been a disease of the twentieth century. An increased prevalence of diverticulosis and its associated disease states were seen in the early 1900s following the Industrial Revolution in the late 1800s which lead to an increased dietary intake of milled grains and refined sugars in industrialized nations. The increased availability of refined grain and sugars resulted in a concomitant decrease of dietary fiber intake. The relationship between dietary fiber and diverticulosis has been supported by numerous studies in the past century. Early studies by Painter and Burkitt compared dietary fiber intake between populations in the United Kingdom and Sub-Saharan Africa and found decreased stool weight and stool transit times in the UK population. In westernized populations, those who consumed a diet high in vegetables and dietary fiber have been found to have decreased rates of diverticulosis while those patients which diets rich in meats are found to have increased rates of diverticular disease, further supporting the dietary hypothesis. While life expectancy differences between African and the UK has been purported to confound the findings of Painter and Burkitt, additional data has

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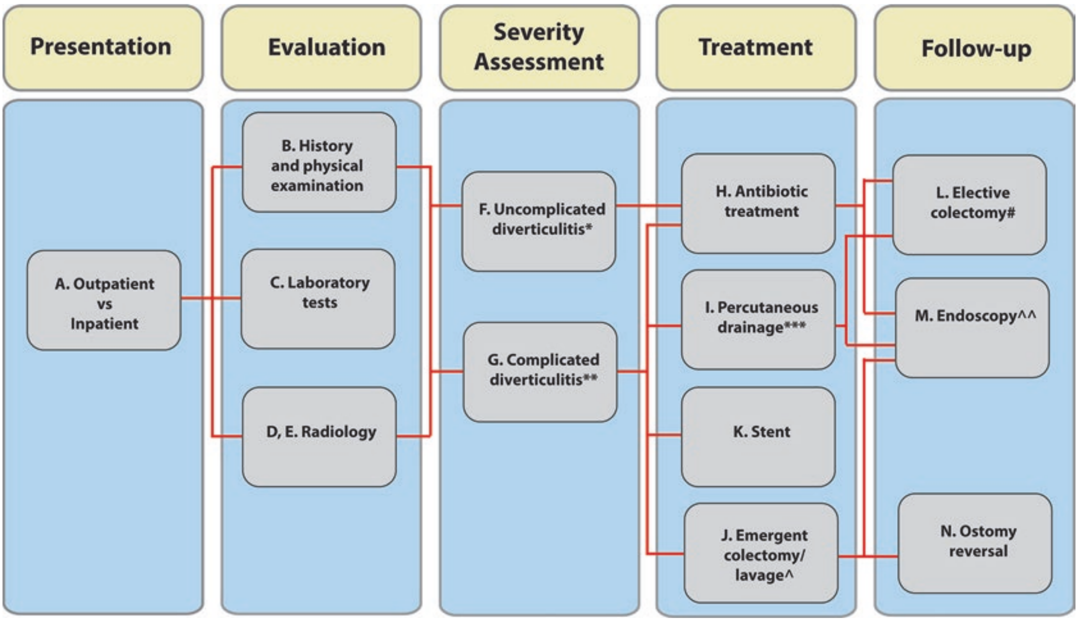

Fig. 45.1 Algorithm for colonic diverticulitis. *Uncomplicated diverticulitis can typically be treated by antibiotic therapy alone. **Complicated diverticulitis can present with acutely with a perforation or in a delayed manner with an associated fistula or stricture. Perforated diverticulitis can be classified according to the Hinchey classification scale. ***Abscesses over 3 cm are unlikely to resolve with antibiotic management alone and should be drained percutaneously. ^Patients who do not improve with antibiotics and percutaneous drainage, or those who present in extremis, should undergo operative intervention to resect the diseased colon. #Not all patients with a history of diverticulitis will require elective colectomy after resolution of symptoms and the decision to undergo elective resection should be individualized. ^^Patients presenting with acute diverticulitis should undergo colonoscopy following resolution of symptoms

arisen that suggests as African countries the adoption of a more westernized diet in these regions is associated with increasing rates of diverticular disease. Historically, consumption of some foods such as nuts, seeds, and popcorn, was thought to lead to diverticular obstruction and incite episodes of diverticulitis in patients with diverticulosis. The belief of these types of foods cause of diverticulitis does not hold merit and dietary modification to avoid these foods in patients with a history of diverticulosis is not necessary.

Non-dietary theories also exist for the development of diverticulosis. Increased pressure in the sigmoid colon is associated with increase visualization of diverticula on cineradiography, suggesting that colonic segmentation as a result of circular muscle contraction within the sigmoid colon leads to high-pressure areas within the lumen. These elevated pressures, over time, can lead to the mucosal herniation and the development of diverticula. Increased deposition of elastin within the taenia coli has also been associated with increased rates of diverticulosis when compared with normal colon. Colonic segments associated with diverticulitis are typically shortened, with a thicker muscularis propria, compared with normal colon. This shortening is suggested to be the result of deposition of elastin within the taenia coli. While the exact cause of the elastin deposition is unclear but patients with diverticulosis were identified to have a 200% increase in elastin content in the taenia coli of patients with diverticulosis compared with controls. Despite increases in circular muscle thickness, alterations in collagen within the colon wall lead to decreased compliance of the colon and increased rates of submucosal tears and mucosal herniation.

The precise mechanism of progression from diverticulosis to acute diverticulitis remains incompletely understood. Some suggest that it is

similar to appendicitis in that diverticular obstruction leads to bacterial overgrowth, wall ischemia within the diverticulum, mucosal injury and perforation. The presentation of diverticulitis can range from localized inflammation within a colonic segment to free perforation and frank fecal peritonitis. Infection from diverticulitis is often mixed aerobic and anaerobic pathogens of colonic origin. Typical aerobic bacteria isolated include, Escherichia coli, Klebsiella, and alpha-hemolytic Streptococci, while typical anaerobic isolates include Bacteroides, Peptostreptococcus, Clostridia, and Fusobacterium (Table 45.1).

A–C. The clinical presentation of acute diverticulitis is highly dependent on the severity of disease at the time of diagnosis. Typically, patients are compiled into two broad categories, uncomplicated and complicated diverticulitis. Uncomplicated diverticulitis typically exhibits a milder presentation and is more likely to respond to medical therapy and can often be treated as an outpatient depending on disease severity. Complicated diverticulitis is used as an encompassing term for diverticulitis with associated free perforation, abscess, fistula, obstruction, or stricture, which requires inpatient treatment. Typically, patients will present with varying degrees of abdominal pain, often localized to the left lower quadrant. These patients often will exhibit fevers as well as an associated leukocytosis. Occasionally a mass in the left lower quadrant can be palpated. The presence of fecaluria, pneumaturia or pyuria increases the suspicion for a colovesical fistula. Patients with free perforation, and either purulent or feculent peritonitis, will exhibit severe tenderness with rebound tenderness and guarding.

Table 45.1 Modified Hinchey classification

Ia	Confined pericolic inflammation or phlegmon
Ib	Pericolic or mesocolic abscess
II	Pelvic, distant intraperitoneal, or retroperitoneal abscess
III	Generalized purulent peritonitis
IV	Generalized feculent peritonitis

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D. Computed tomography (CT) is the current gold standard for diagnosis of diverticulitis. CT imaging provides detailed cross sectional images, which allow for confirmation of the clinical diagnosis, staging of disease severity, and guidance of treatment. Signs of diverticulitis on CT imaging include the pericolic fat stranding and colonic wall thickening in the presence of diverticula. Signs of complicated diverticulitis include pericolic abscess formation, intraperitoneal fluid and air suggestive of free perforation. The presence of complicated diverticulitis on CT imaging is associated with increased rates of recurrence, complications related to the disease, and requiring operative intervention.

E. The original Hinchey classification system used to describe severity of diverticulitis was based on both clinical and intraoperative findings. This classification system has been modified to incorporate the detailed imaging information now available with the advent of CT imaging. Grade 0 refers to colonic wall thickening in the absence of pericolic fat stranding, Grade 1a refers to colonic wall thickening associated with pericolic fat stranding; Grade 1b includes the addition of a pericolic abscess. Grade 2 refers to a remote intraabdominal or pelvic abscess. Grades 3 and 4, which are difficult to distinguish by imaging findings alone, refer to purulent and feculent peritonitis respectively. Patients presenting with more severe disease, an associated abscess, and/or perforation, are more likely to experience disease recurrence following a trial of nonoperative management. This knowledge is useful when considering treatment options for patients with Grade 2 or higher presentations of diverticulitis and is useful for patient counseling.

F. Acute uncomplicated diverticulitis commonly presents with left sided abdominal pain, fever, and leukocytosis. Occasionally a left sided abdominal mass can be palpated. The treatment of acute uncomplicated diverticulitis is dependent on disease severity. Recent studies have examined the utility of antibiotic therapy for patients presenting with an initial episode of mild acute uncomplicated diverticulitis and have found that it may not affect patient outcomes compared with intravenous fluids alone. Outpatient management of mild

cases of uncomplicated diverticulitis is successful in many patients but should be attempted only in reliable patients with the ability to tolerate oral intake and oral antibiotics. For patients not able to be managed at home, inpatient hospital stay with intravenous fluids, antibiotics, and bowel rest is recommended. Antibiotic regimens for the treatment of diverticulitis are often institution specific. Treatment is aimed at coverage of the aerobic and anaerobic flora most commonly identified in diverticular perforations is advocated, both single and multi-agent approaches are acceptable.

G. Patients presenting with complicated diverticulitis as manifested by presence of a segment inflamed colon containing diverticula with an associated abscess, perforation, fistula, obstruction, or stricture are typically admitted to the hospital and managed through a multimodal approach dependent on the level of disease severity.

H. Patients presenting with perforated diverticulitis and diverticular abscesses should be treated with bowel rest and intravenous antibiotics.

I. Patients who do not respond to antibiotics alone should be evaluated by interventional radiology for percutaneous abscess drainage. Larger abscesses, >3–4 cm, are unlikely to resolve with antibiotic therapy alone. The utilization of a multimodal nonoperative management, incorporating antibiotics and image guided directed drainage catheters, is successful in resolving 91% of presentations with acute complicated diverticulitis. Patients who do not respond to antibiotics and catheter drainage should be considered for surgery.

J. Patients presenting with perforated diverticulitis and diffuse peritonitis, and those who fail to improve with nonoperative management, should be managed surgically. Up to 25% of patients hospitalized with complicated diverticulitis will fail non-operative treatment and require surgery for their diverticular disease. Sigmoid colectomy with end colostomy and rectal stump, or Hartmann's procedure, has long been the standard for surgical treatment of perforated diverticulitis. This technique removes the diseased colon diverts the fecal stream in patients with ongoing peritonitis who may not tolerate a primary anastomosis. Sigmoid resection with primary colorectal anastomosis and proximal diversion is also an acceptable option for management of perforated diverticulitis. This approach benefits by obviating the need for repeated laparotomy for stoma reversal. When primary anastomosis is undertaken an intraoperative leak test should be performed. Both laparoscopic and open approaches can be undertaken and are largely dependent on patient characteristics and surgeon expertise. Laparoscopic lavage has been advocated as an option in the surgical treatment algorithm for perforated diverticulitis. This technique involves performing a laparoscopic lavage of the peritoneal cavity while leaving the diseased sigmoid colon in place. The DILALA trial described that laparoscopic lavage was safe and feasible in patients with Hinchey III diverticulitis and single center data suggest it is a viable option in Hinchey III diverticulitis in experienced hands. The main criticism of this technique is that it leaves behind the offending colon and source of sepsis. Additionally, this technique has higher rates of surgical reintervention when compared with sigmoid colectomy. Both the SCANDIV and LADIES trials demonstrated significantly higher re-intervention rates in those patients being treated with laparoscopic lavage compared with sigmoid colectomy. Though, while reintervention rates appear to be higher, in patients with Hinchey III diverticulitis, mortality appears to be similar at 30 and 90 days. Currently the use of laparoscopic lavage in purulent or feculent peritonitis would not be recommended in these scenarios.

K. Diverticular strictures can present as a complete or partial large bowel obstruction in patients with a history of diverticulitis. Diverticular strictures account for far fewer large bowel obstructions than colon cancer, though they are associated with a higher in hospital mortality rate. The most common location for these strictures is within the sigmoid colon. Stricture management is most dependent on whether a partial or complete obstruction exists. Patients presenting with partial obstruction will endorse continued flatus and bowel movements despite

abdominal distention and radiologic evidence of a relative obstruction in the colon. These patients can be managed with bowel rest, intravenous fluids, and antibiotics if ongoing infection is present. If patients improve with these initial measures, and are able to be decompressed, they can undergo elective resection with primary anastomosis.

Self-expanding metallic stents (SEMS) can be used in situations of partial obstruction where a guidewire can be passed beyond the point of obstruction. Proponents of the use of SEMS in diverticular stricture quote high mortality rates for patients undergoing emergent colostomy or colon resection for obstruction as a justification for its use. Compared with malignant obstructions, deployment of SEMS for diverticular strictures can be technically challenging secondary to longer segments of diseased colon and increased tortuosity. SEMS have higher rates of stent migration in benign disease leading some to caution against their use in diverticular strictures. Ideally, surgical intervention should follow within a month of stent placement. Patients presenting with large bowel obstruction who do not improve with nonsurgical measures should proceed for operative interventions to resect the diseased colon.

L. Fistulas can develop as a result of perforated diverticulitis. Colovesical fistulas, between the bladder and colon, are the most common presentation of fistula associated with diverticulitis, accounting for 65% of diverticular fistulas. Patients with colovesical fistulas present with urinary symptoms and polymicrobial urinary tract infections. Additionally these patients may exhibit fecaluria and pneumaturia. A CT scan finding of air in the bladder, in the absence of instrumentation, is highly suggestive of a colovesical fistula. Colovesical fistulas should be managed surgically. Typically the sigmoid colon is adherent to the bladder. Often the fistula opening into the bladder is small and can be suture repaired or more often left open. These small fistulas usually heal within 1–2 weeks after surgery. A cystogram should be obtained to document healing prior to postoperative bladder catheter removal. Following sigmoid colectomy, a primary anastomosis is appropriate in these circumstances. Additional common fistulous presentations include colovaginal, coloenteric, and colocutaneous fistulas. Often, in each case, the omentum can be used if available to place between the new colonic anastomosis and the site of the fistula repair.

M. Elective resection for diverticular disease has become a controversial topic. Following resolution of a nonoperatively managed episode of uncomplicated diverticulitis, somewhere between 13–30% of patients will have a repeated episode. Additionally the majority of recurrences happen within the first year of initial presentation suggesting these early "recurrent" presentations may simply reflect inadequate treatment of the primary occurrence. Risk factors for recurrence of diverticulitis include a family history of diverticulitis, length of involved colon being >5 cm, and presence of a retroperitoneal abscess. Interestingly right-sided diverticulitis was unlikely to recur. Additionally, it is rare for patients to present with severe complicated diverticulitis following an episode of nonoperatively managed uncomplicated diverticulitis. The risk of requiring emergency surgery following a resolved episode of nonoperatively managed acute diverticulitis is low and estimated at 1 in 2000 patient years. Recurrent diverticular disease is unlikely to present requiring emergent colectomy and colostomy formation, past recommendations for elective colon resection after a patient's second episode of diverticulitis are now outdated and have been replaced by a more individualized approached to patient selection for operative management. Increasing episodes do not appear to be a risk factor for increasing rates of diverticular related morbidity or mortality, as patients presenting with complicated diverticulitis are more likely to do so on their first presentation.

Young patients, <50 year of age, were historically though to have a more virulent form of diverticulitis that mandated resection. In actuality, young patients respond similarly to older patients in response to antibiotic therapy. Additionally, recurrence rates are similar between young and older patients. Young patients should therefore be managed accord-

ing to their clinical presentation as opposed to their age.

Immunocompromised patients are at increased risk for poor outcomes related to diverticulitis. Transplant recipients on chronic immunosuppressive therapy have an increased rate of mortality associated with nonoperatively managed diverticulitis, approximately 50%. Immunocompromised patients more commonly present with free perforation, more frequently require emergency operations, and have a high postoperative an in-hospital mortality, estimated at 39%.

N. Endoscopic evaluation of the colon following an episode of diverticulitis is often recommended despite low rates of identifying colorectal cancer in patients following episodes of diverticulitis are low and mirror that of the general population. When performed, endoscopic examinations are deferred until at least 6 weeks following an episode of acute diverticulitis given concern of injuring the diseased colon. Some more recently have questioned the need for delaying endoscopic examination citing low rates of perforation during acute episodes of diverticulitis despite technically difficult examinations with decreased rates of cecal intubation. These groups advocate for endoscopic examination for its potential to provide additional information, which can alter the management strategy.

O. Rates of colostomy reversal following Hartmann's procedures are low compared with rates of reversal in patients with diverting ileostomy following sigmoid colectomy for diverticulitis. Hartmann's procedure and sigmoid colectomy with primary anastomosis and diverting ileostomy have similar complication rates following the initial resection. Decreased complication rates related to stoma reversal may favor primary anastomosis and proximal diversion in select patients.

P. Right-sided diverticulitis is an uncommon presentation in the United States though occurs frequently in Asian populations. Right sided diverticulitis can often be confused with appendicitis on the basis of history and physical examination and historically has created a uncertainty in operative decision making with regards to extent of resection should diverticulitis be encountered. With the widespread availability of computed tomography, the ability to preoperatively diagnose right-sided diverticulitis can help guide clinical decision-making. Right-sided diverticulitis can be managed similarly to sigmoid diverticulitis. Those patients who do not exhibit peritonitis can be managed with IV antibiotics and bowel rest, with percutaneous drainage should it be necessary. Tan et al. showed very good long term outcomes for those patients with right sided diverticulitis who were treated nonoperatively at the time of initial diagnosis. Rates of operative intervention for right-sided diverticulitis are declining within the United States, possibly due to advancements in use of percutaneous drainage. Patients who do not respond to conservative therapy should undergo operative intervention through either a laparoscopic or open approach. Laparoscopic approaches are safe and feasible and associated with reduction in postoperative pulmonary complications in these patients. When the diagnosis right-sided diverticulitis is made intraoperatively in those patients who did not undergo preoperative imaging, treatment options include right colectomy or performing an appendectomy with subsequent medical treatment on the diverticulitis. Recurrence, as with other forms of diverticulitis does not in and of itself mandate resection, patients should be managed on an individual basis with regards to pursuit of acute or elective operative management.

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Colonic Conditions: Large Bowel Obstruction

46

Sarah B. Stringfield and Bard C. Cosman

Refer to Algorithm in Fig. 46.1

A. Although large bowel obstruction (LBO) may have a long prodromal period, the clinical presentation is usually acute. A thorough history is important, though focus should be on bowel movements, abdominal pain, and flatus. Common associated symptoms include abdominal distention, crampy pain, nausea and vomiting, obstipation or constipation, and bloating relieved by defecation. Significant prodromal symptoms may include chronic constipation, stool caliber change, and intermittent left lower quadrant pain over months to years. A physical examination should be performed, focusing on the abdomen to assess for tenderness, peritoneal signs, and any mass or fullness. Additionally, the patient should be checked for incarcerated inguinal and femoral hernias, and a rectal examination should be performed to assess stool consistency and the contents of the rectal vault.

B. Due to potential morbidity and mortality, suspicion of LBO should lead to rapid evaluation and surgical consultation. Pain relief, control of vomiting with antiemetics and/or nasogastric decompression, and correction of fluid and electrolyte abnormalities should occur simultaneously with diagnostic evaluation. It is unproven, but reasonable, to give antibiotics with gram-negative aerobic and anaerobic coverage to patients with suspected or confirmed LBO if the patient appears septic and there is concern for perforation. Laboratory studies can assess degree of dehydration and electrolyte imbalance, and evaluate for infection, anemia, and ischemia.

C. Radiographic studies can confirm obstruction and identify its cause or other pathology causing the patient's symptoms. Computed Tomography (CT) is the imaging of choice for suspected LBO, as it can confirm the diagnosis, identify intraluminal, mural, and extramural causes, and detect inflammation and bowel ischemia. The presence of a transition point in the colon can make the diagnosis of LBO, though it does not always distinguish between mechanical obstruction and pseudo-obstruction. Intravenous and oral contrast can often help delineate between partial and complete obstruction, ileus, and small bowel obstruction. Rectal contrast may be useful when the suspected obstruction is in the rectum or sigmoid, and it allows a clearer distinction between mechanical and functional obstruction. Water-soluble contrast enema

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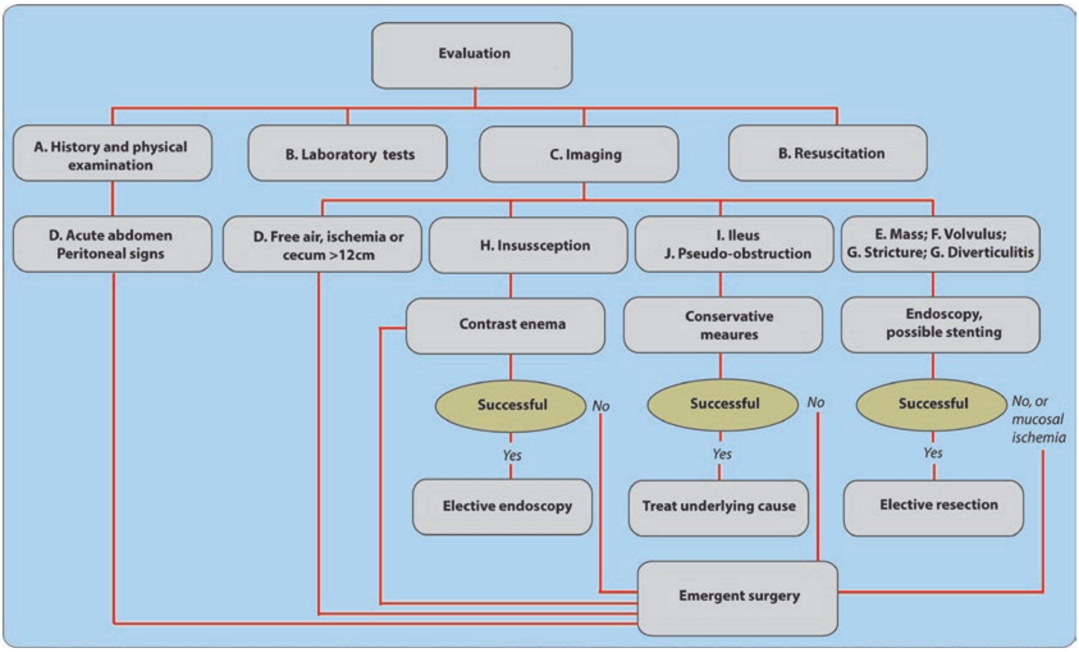

Fig. 46.1 Algorithm for evaluation and management of large bowel obstruction

with plain films has been replaced by CT with rectal contrast, but the enema itself has therapeutic value in intussusception, regardless of what imaging modality is used to monitor it. Plain films are of little value when compared to CT, although upright chest radiographs may be useful as an initial screen for pneumoperitoneum, pneumatosis intestinalis, and portal venous gas, suggesting a concomitant perforation or ischemia that might necessitate prompt surgical intervention. Sigmoid or cecal volvulus (Fig. 46.2) may have a kidney-bean or giant-loop appearance on abdominal radiographs. Abdominal radiographs may also help distinguish constipation from LBO and may localize the site of obstruction, showing colonic dilation proximal to the obstruction and a paucity or absence of gas distal to the obstruction.

D. All patients with peritoneal signs on abdominal examination or signs of perforation or ischemia on radiographs should undergo prompt surgical exploration. Cecal diameter greater than 12 cm, unless it is known to be chronic, should raise concern for impending perforation, and urgent decompression should be considered, either via endoscopic or surgical intervention. The patient without signs of an acute abdomen can undergo further evaluation and consideration of whether surgical or endoscopic intervention is indicated,

Fig. 46.2 Cecal volvulus on plain film

or whether non-operative measures, e.g. for pseudo-obstruction, may be appropriate.

E. Colonic malignancy is the most common cause of LBO. The most common locations are the rectum, sigmoid colon, and the splenic flexure; while lesions in the right colon, where stool is liquid, require the lumen to be almost completely closed to cause clinical LBO. In the absence of perforation or ischemia, endoscopic dilation and stenting of masses and strictures may be helpful in selected cases, and may provide an alternative to multistage surgery. Stenting or dilation permits relief of acute obstruction, resuscitation of the patient, and mechanical bowel preparation prior to resection and re-anastomosis, thus potentially avoiding ileostomy or colostomy. Stenting is most often successful for left-sided lesions. Right-sided lesions and distal rectal lesions tend to be much more difficult technically and not great candidates. Patients with left-sided obstruction may be treated with a decompression tube as a bridge to surgery. Palliative stenting may be an option in patients who are poor surgical candidates or who have advanced cancer.

F. Acute colonic volvulus may account for 10–15% of LBO. In the United States, sigmoid volvulus is 3–4 times more common than cecal volvulus; however, their relative frequency varies greatly internationally. In a stable patient, sigmoid volvulus can be treated with endoscopic reduction and decompression. Yet, if mucosal ischemia is found on colonoscopy, the procedure should be aborted and the patient should undergo urgent surgical exploration. Recurrence of volvulus after decompression is common and expected, therefore surgical resection is indicated in all but the sickest patients. Elective resection should be performed in all patients with cecal volvulus and in patients with sigmoid volvulus following successful endoscopic reduction, if they are surgical candidates from a co-morbidity standpoint. Emergent operation is indicated in patients for whom endoscopic reduction is not successful.

G. Acute diverticulitis can rarely present as partial or complete LBO due to bowel wall edema and/or pericolonic inflammation. Obstruction usually occurs after multiple episodes, which causes narrowing and stricture formation. Diverticulitis is seen on CT as segmental, symmetric bowel wall thickening with hyperemia, in a longer segment than a typical malignancy (Fig. 46.3). However, it can be difficult to distinguish radiographically between diverticulitis and cancer, so colonoscopy and biopsy is valuable if there is the opportunity. Principles of treatment are the same as with malignant obstruction. Elective resection should be offered to patients with recurrent diverticulitis with LBO, following resolution of an acute episode.

H. Intussusception can successfully be treated with a contrast enema in 60–80% of cases. This is more successful in children, in whom a pathologic lead point is unlikely. In adults, a pathologic lead point is usually present, and patients are more likely to require elective surgery after successful reduction by contrast enema. The lead point should be investigated by colonoscopy after reduction of the intussusception. Urgent operation is indicated in all patients with signs of peritonitis or bowel perforation, or if reduction with contrast enema is unsuccessful.

I. Colonic ileus may not exist as a distinct entity: certainly, the colon shares in generalized ileus, and arguably isolated colonic ileus may be the

Fig. 46.3 Diverticulitis on CT

same as acute colonic pseudo-obstruction. In principle, adynamic ileus of the colon is treated with conservative measures, including correction of fluid and electrolyte abnormalities and treatment of the underlying disorder. Nasogastric tube decompression may be helpful if the patient is vomiting. Medications that slow colonic motility should be stopped or avoided.

J. Acute colonic pseudo-obstruction, also called Ogilvie's syndrome, is treated the same as colonic ileus if there are no signs of colonic perforation. Additionally, IV neostigmine and/or colonoscopic decompression may be effective. Surgery may be required in refractory cases and those complicated by perforation.

Suggested Reading

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47 Colonic Conditions: Volvulus

Richard Garfinkle and Marylise Boutros

Refer to Algorithm in Fig. 47.1

Introduction

Colonic volvulus accounts for 10–15% of all large bowel obstructions in Western countries, and is the third leading cause behind colorectal cancer and diverticular disease. Volvulus refers to torsion of a segment of bowel on its mesentery; colonic volvulus involves the sigmoid colon and cecum in over 95% of cases, with the transverse colon and splenic flexure more seldom affected. With rotation of the redundant and mobile segment of colon, closed-loop luminal obstruction and mesenteric malperfusion ensue, leading to the symptoms of bowel obstruction and possible ischemia. If not treated urgently, colonic volvulus can be fatal, and carries a variable mortality rate that can exceed 50% when gangrenous colon is present.

The sigmoid colon accounts for the majority of colonic volvulus, with a variable incidence. The anatomic abnormality that predisposes to volvulus is a long redundant sigmoid colon with a narrow mesenteric attachment.

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The incidence of cecal volvulus has increased steadily over the past decade. Like its sigmoidal counterpart, cecal volvulus occurs secondary to organoaxial rotation of the colon. The basic anatomic requirement is a sufficiently mobile cecum and ascending colon, which is present in 11–22% of adults according to autopsy studies. Cecal bascule, a distinct and less commonly observed entity, involves anterosuperior folding of the cecum over a fixed ascending colon. Though it presents similarly to cecal volvulus, it does not involve axial rotation of the bowel and thus does not result in mesenteric vascular obstruction.

A. Sigmoid volvulus usually occurs in the elderly with a mean age of presentation of 70 years old, and affects males in a 2:1 ratio. Patients typically have many medical comorbidities, and often suffer from chronic constipation, cathartic/laxative abuse, or colonic motility disorders. They are also disproportionately institutionalized with neuropsychiatric conditions. In many third-world countries, where sigmoid volvulus represents the leading cause of large bowel obstruction, Chagas disease and high-fiber diets have been implicated in the pathogenesis of the redundant sigmoid, and affected adults are typically younger, between 40–50 years old. Patients with a cecal volvulus are usually female (3:1) and 10–20 years younger than those with sigmoid volvulus. Precipitating

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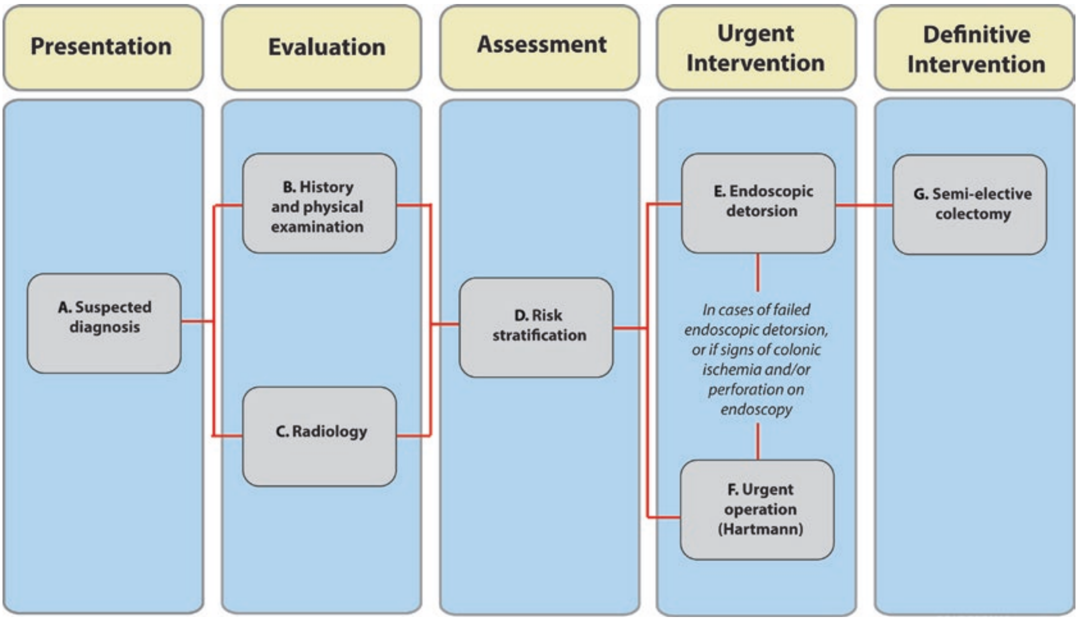

Fig. 47.1 Sigmoid volvulus algorithm

factors include surgical adhesions, congenital bands, pregnancy, and colonic atony.

B. Colonic volvulus may be difficult to distinguish from other forms of bowel obstruction on history and physical examination alone. Sigmoid volvulus tends to have an insidious onset of progressive abdominal pain, followed by nausea, vomiting, abdominal distension and obstipation. Patients tend to present after 3–4 days of symptoms, and perhaps longer in institutionalized patients. The symptoms of cecal volvulus are similar, but affected individuals are more likely to present earlier with steady abdominal pain. In both cases, physical examination may reveal varying degrees of abdominal tenderness, distension and tympany. The presence of hemodynamic abnormalities (tachycardia or hypotension), fever, rigidity, severe guarding, and rebound tenderness are indicative of colonic ischemia and/or perforation.

C. The diagnosis of colonic volvulus usually relies on a combination of imaging modalities (Fig. 47.2). Plain abdominal radiographs are diagnostic of sigmoid volvulus in roughly 50% of cases, and classically feature a markedly distended, gas-filled anhaustral colon extending from the pelvis to as high as the diaphragm, referred to as the "bent inner tube", "omega", or "coffee-bean" sign. The addition of a water-soluble contrast enema can improve the diagnostic accuracy of plain radiograph up to 90%, giving the characteristic "bird's beak" sign as the contrast tapers off to the point of obstruction. Abdominal radiographs are less diagnostic of cecal volvulus, with only 15% of cases readily recognizable. Unless the clinical exam or radiograph findings warrant urgent exploratory laparotomy, contrast-enhanced CT scan has become the diagnostic test of choice for both sigmoid and cecal volvulus. The "whirl sign" is specific for volvulus, representing the swirling appearance of the collapsed bowel and its mesentery.

D. The initial assessment of a patient with suspected colonic volvulus should focus on identifying signs of colonic ischemia or perforation. Vital sign abnormalities and/or peritonitis on exam, free air on plain radiograph or CT scan, and leukocytosis or elevated serum lactate are all indicative of ischemia or perforation, and the presence of

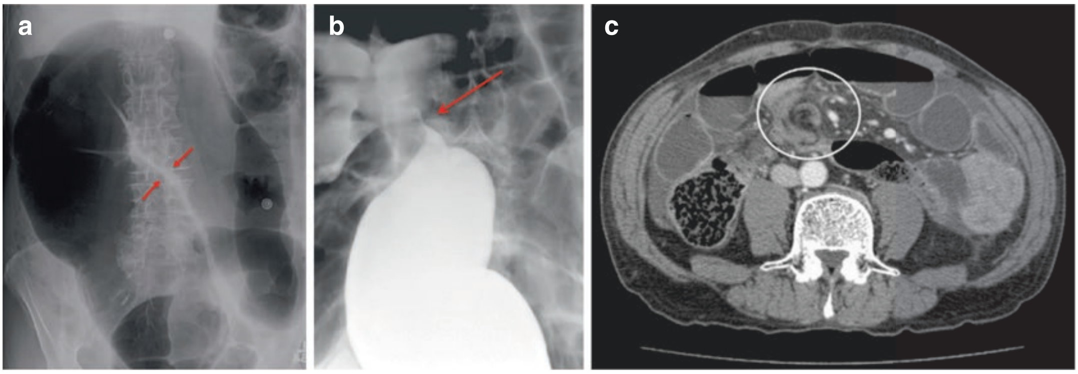

Fig. 47.2 Characteristic imaging findings for sigmoid volvulus. (**a**) "Coffee-bean" sign on plain radiograph. Note the thick inner wall, representing a double-layer of apposed bowel wall (red arrows). (Reused with permission © 2015 Springer) (**b**) "Bird's beak" sign with rectal contrast. Note the smooth tapering of contrast as the colon narrows at the point of obstruction (red arrow). (Reused with permission © 2015 Springer) (**c**) "Whirl" sign seen on CT scan (white circle). (Reused with permission © 2013 John Wiley and Sons Inc.)

any one of these should prompt the consideration for urgent operation. Management begins with the general principles of bowel obstruction and/or intra-abdominal sepsis: fluid resuscitation, correction of electrolyte abnormalities, bladder catheterization for urine output monitoring, nasogastric tube insertion (to decompress the stomach and small bowel, and to prevent aspiration), and intravenous antibiotics in cases of ischemia or perforation.

E. In the absence of suspected ischemia or perforation, the initial treatment of sigmoid volvulus is typically endoscopic detorsion with flexible sigmoidoscopy (Fig. 47.1). If signs of colonic ischemia or gangrene are observed endoscopically (blood or dusky mucosa), detorsion and colonic manipulation should be immediately aborted to avoid perforation of the bowel or bacterial translocation, and an urgent operation should be planned. In the absence of these signs, detorsion is successful in 60–95% of cases. Following detorsion, a rectal tube should be left in place to allow for continued colonic decompression and to prevent re-torsion of the colon. To ensure proper placement, the rectal tube can be inserted over a guide wire through the sigmoidoscope, reaching just past the point of the volvulus. If detorsion is unsuccessful, an urgent operation is warranted.

Unlike with sigmoid volvulus, endoscopic detorsion is not recommended as part of the management strategy of cecal volvulus. Various small studies have reported low success rates in achieving cecal reduction with endoscopy, and have described it as technically challenging. As such, surgery is always performed to relieve the obstruction, detorse the bowel, and address the colon which is prone to volvulize again.

F. Many operative interventions have been described for the treatment of sigmoid volvulus with varying success rates: simple detorsion, sigmoidopexy (intra- or extraperitoneal), mesosigmoidoplasty (Fig. 47.3), and colectomy with or without primary anastomosis. Of all, sigmoid colectomy is the best option to prevent recurrences. The decision to perform a primary anastomosis must take into account the timing of the operation (urgent vs. semi-elective), intraoperative findings (bowel viability, contamination), the clinical status of the patient (hemodynamics, metabolic derangements), and the patient's baseline risk (nutritional status, comorbidities).

All urgent operations should be performed via midline laparotomy. In general, colectomy with end colostomy (with mucous fistula or Hartmann's closure) should be performed in the presence of gangrenous

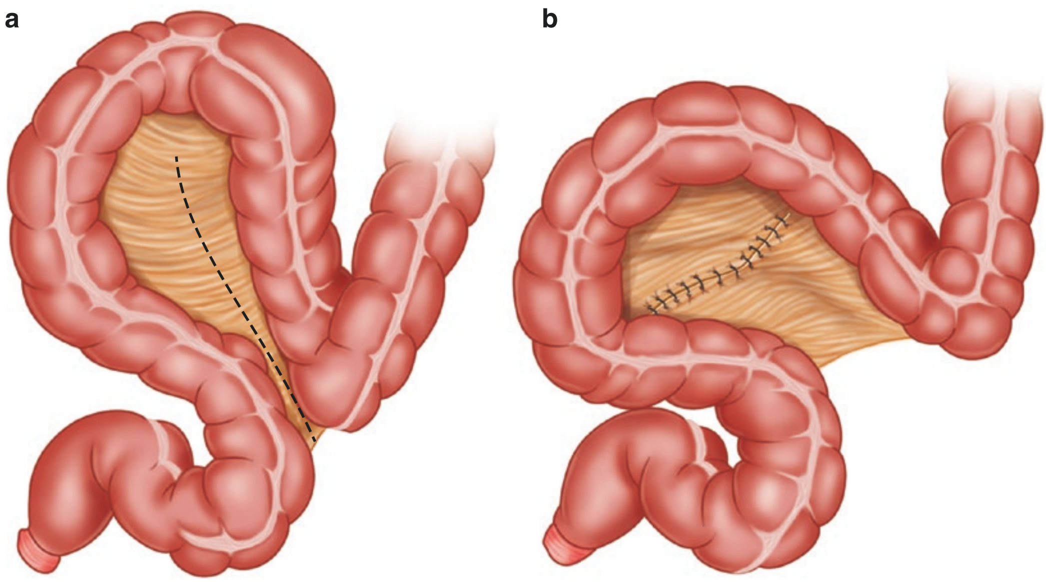

Fig. 47.3 Mesosigmoidoplasty as a non-resective therapy for sigmoid volvulus. (**a**) Note the pathogenic long mesosigmoid and the narrow attachment at the base. (**b**) Note how the longitudinal incision is closed transversely, resulting in a shorter sigmoid loop and broader base. (Reused with permission from Gordon PH, Nivatvongs S, editors. Principles and practice of surgery for the colon, rectum, and anus. third ed. New York: Informa Healthcare; 2007 (permission from editors))

colon, fecal contamination, hemodynamic instability or severe malnutrition/comorbidities. This allows for a relatively short operative time and diminishes the risk of anastomotic leak. If viable colon is encountered at urgent laparotomy in a clinically well patient, primary anastomosis with or without proximal diversion may be safe. The role of laparoscopy in the urgent setting is not well defined, and more evidence is needed before endorsing this technique as a standard approach.

For a cecal volvulus, the operation of choice will largely depend on bowel viability at the time of operation. In 20–30% of cases, the cecum is found to be gangrenous or nonviable, mandating a resection. A right hemicolectomy is typically necessary due to the extent of diseased colon, but ileocecectomy may be considered. The decision to perform a primary anastomosis or to mature an ileostomy with or without a mucus fistula will depend largely on intraoperative findings. Small observational studies have reported primary anastomosis as a safe option in the emergency setting. However, in the setting of gross perforation and fecal contamination with generalized peritonitis, an ostomy should be strongly considered.

The best surgical intervention when facing a viable cecum is less obvious, largely due to a paucity of literature and high quality evidence. The options include simple detorsion, segmental resection, cecopexy, and cecostomy, and each choice must be considered in terms of its ability to prevent recurrence and its risk for postoperative morbidity and mortality. Simple detorsion is associated with the highest rate of recurrence, reaching 20% in some studies, as it does nothing to address the pathologically mobile colon. Coupled with a high rate of mortality, this technique is not recommended. Segmental resection essentially eliminates the chance of recurrence, but is associated with a postoperative morbidity rate of greater than 30%, mostly due to organ-space and superficial surgical site infections. The data on mortality

is more difficult to interpret, but when cases of resection for viable bowel are distinguished from those performed for gangrenous bowel, mortality appears to be very low. Cecopexy, which involves suture fixation of the cecum to the lateral abdominal wall, is another valid option (Fig. 47.4). Recurrence rates are highly variable, as the success of this procedure depends on proper suture placement. Because the colon is not entered, infectious complications are lower than with resection, and mortality is acceptable. Operative cecostomy appears to be associated with both a higher rate of recurrence and postoperative infections than cecopexy, and offers the added morbidity of a new ostomy. However, in patients who cannot tolerate a laparotomy or general anesthesia, tube cecostomy can be inserted by Interventional Radiology under local anesthesia. The use of laparoscopy for any of the above operative treatments is acceptable in the hands of an experienced minimally-invasive surgeon, but should not be entertained if gangrenous bowel is expected.

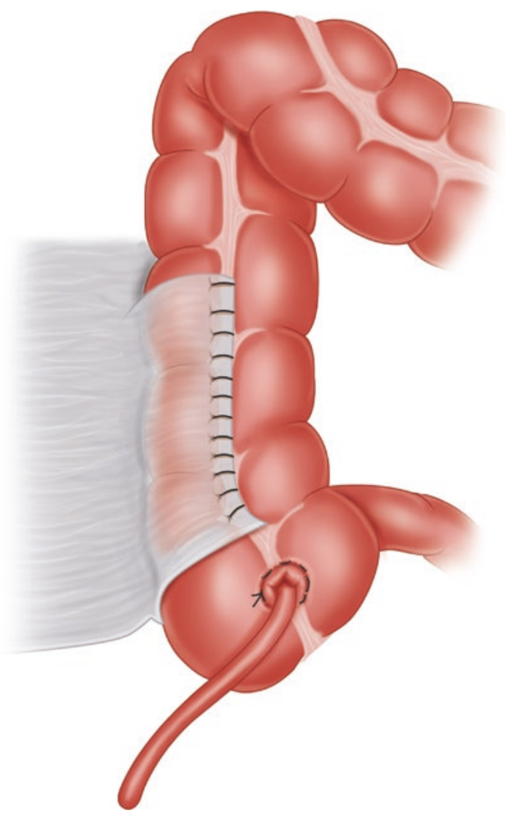

Fig. 47.4 Cecopexy (with cecostomy) with peritoneal flap as a non-resective therapy for cecal volvulus. The peritoneal flap is created at the level of the ileocecal valve and is extended to cover the ascending colon up to, but not -ding, the hepatic flexure. The flap is sutured to the taenia of the ascending colon using interrupted non-absorbable sutures. (Reused with permission from Gordon PH, Nivatvongs S, editors. Principles and practice of surgery for the colon, rectum, and anus. third ed. New York: Informa Healthcare; 2007 (permission from editors))

G. Successful endoscopic detorsion of sigmoid volvulus converts an urgent operation to a semi-elective operation. Recurrence rates after endoscopic detorsion alone eclipse 50% within a few months of the index volvulus presentation, lending more support towards early operative intervention on the index admission, barring prohibitive medical comorbidities. The optimal timing for surgery is not well established; we aim for 5–7 days from endoscopic detorsion, balancing the benefit of continued colonic decompression and reduction in bowel wall edema with the risks of malnourishing the patient. In the interim, it is our preference that the rectal tube be left in place, and patients can be started on a high-protein high-caloric fluid diet (e.g. Ensure, Boost). Solid diet is avoided as solid bowel movements could dislodge the rectal tube. Patients should also be marked for potential stoma prior to resection. In this setting, sigmoid colectomy can typically be performed by two possible operations.

The first is a segmental resection performed via a limited left iliac fossa incision due to the redundant sigmoid colon which immediately bulges out (Fig. 47.5). The length of sigmoid colon removed is variable, but should include the entire redundant segment that is exteriorized, leaving enough sigmoid on each side for a side-to-side stapled or end-to-end handsewn colocolic anastomosis. When dealing with proximal or distal bowel that is either still too edematous or chronically thickened from repeated insults, an anterior resection with stapled colorectal anastomosis should be considered. This can be performed laparoscopically or via a lower midline incision. The entire

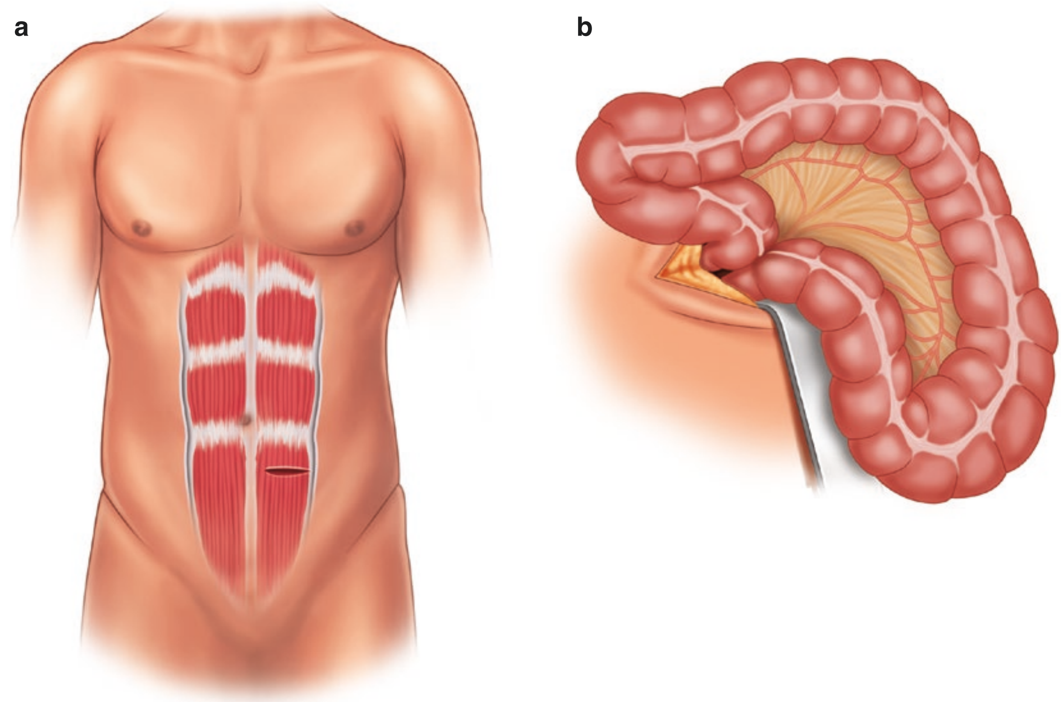

Fig. 47.5 Limited left iliac fossa incision for elective/semi-elective sigmoid resection. (**a**) Note the location of the incision on the abdominal wall. (**b**) Note how the redundant sigmoid colon is easily delivered through the small incision, and the lines of resection are at the abdominal wall. (Reused with permission from Gordon PH, Nivatvongs S, editors. Principles and practice of surgery for the colon, rectum, and anus. third ed. New York: Informa Healthcare; 2007 (permission from editors))

redundant segment is resected down to the rectosigmoid junction and a colorectal anastomosis is performed. Proximal diversion with a loop ileostomy may be used. However, in the dependent patient, a Hartmann's end colostomy may be the most suitable option. Regardless of the choice of anastomosis, recurrence rates after sigmoid colectomy are rare, and should be negligible when the entire redundant sigmoid colon is removed.

Non-resective and non-operative approaches as definitive management for sigmoid volvulus are inferior to sigmoid resection. While they were once performed to minimize postoperative morbidity, most case series have demonstrated equivalent complication rates to segmental colectomy with much higher recurrence rates, leading mostly to their abandonment. Simple operative detorsion is associated with approximately a 40–50% recurrence rate and a 30–35% morbidity rate, and should not typically be performed on its own. When combined with a colonic fixation technique (sigmoidopexy; intra- or extra-peritoneal), recurrence rates are variable but hover around 20–30%. Another option is to combine detorsion with mesosigmoidoplasty, which addresses the long but narrow mesosigmoid, one of the most important pathogenic factors leading to sigmoid volvulus. This technique, which involves broadening and shortening of the mesosigmoid, appears to have greater success than sigmoidopexy, but is still associated with recurrence rates of up to 20% in some reports. In patients deemed unfit for any operation, percutaneous endoscopic colostomy may be performed to fix the sigmoid colon to the anterior abdominal wall. The evidence for this approach is sparse, but small reports support the technique as a viable non-operative option.

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48 Colonic Stricture

Estelle J. Williams and Erin O. Lange

Refer to Algorithm in Fig. 48.1

A. Colonic strictures result from a broad array of benign and malignant colorectal conditions resulting in mechanical blockage of bowel contents. The underlying disease process may reflect luminal, mural, or extramural pathology. In the acute setting, the obstructive nature of colonic strictures results in abdominal pain, distension, changes in bowel movement consistency or frequency, decreased/absent flatus, nausea, and/or vomiting. These symptoms reflect increased contractility in the colon as a physiologic response to relieve the acute obstruction. Although most strictures manifest with some degree of obstruction, the severity and tempo of the symptoms often depend on the underlying cause. For example, patients with a slow-growing malignancy may have a more indolent/subacute course with progressive difficulty with bowel movements, bloating, etc. In the more chronic presentations, patients may also demonstrate weight loss, anemia, or malabsorption.

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B. History and physical examination provide important clues to identify the underlying cause of the stricture. Patients should be asked about duration of obstructive symptoms, diet tolerance and changes, appetite, weight loss, and bowel pattern, including frequency, consistency, and presence/absence of blood. Symptoms such as nausea, vomiting, fever, chills, and complete pain history including degree, location, and contributing factors should be elicited. Presence of fever or other acute symptoms should prompt consideration of perforation secondary to high grade obstruction, or infectious or inflammatory etiologies: history of recent travel, hospital admission, or exposures may suggest tuberculosis, amebiasis, or other infectious colitides. Chronic worsening symptoms suggest malignancy, progressive diverticular disease, inflammatory bowel disease, or radiation-induced stricture. Physical examination should include abdominal exam, with attention to distension, tympany, bowel sounds, and evidence of peritonitis. A rectal exam should be performed to exclude distal neoplasm or anal stricture.

C. Important laboratory tests include complete blood count, chemistry, and coagulation panels. For patients with suspected neoplastic etiology, the tumor marker carcinoembryonic antigen (CEA) should be obtained. If inflammatory bowel disease is suspected, inflammatory markers such as estimated sedimentation

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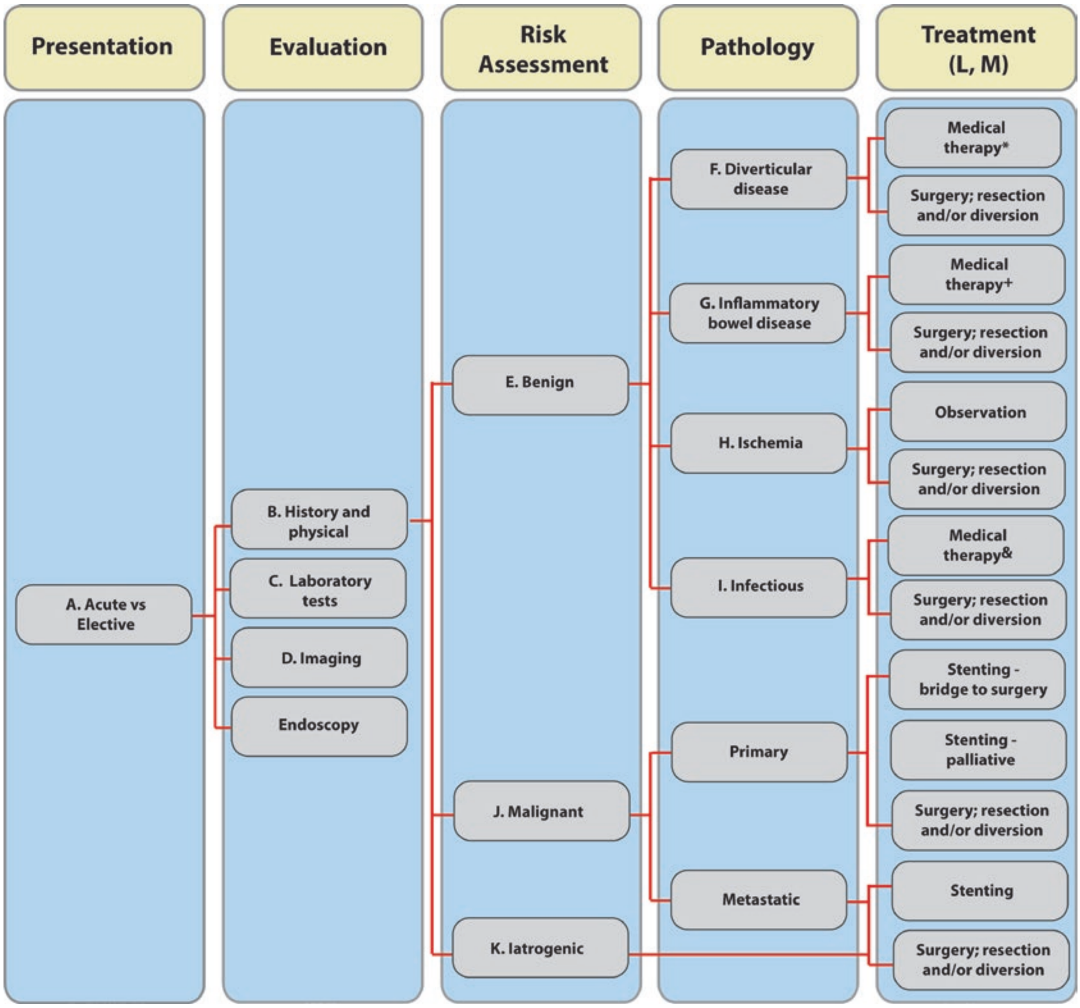

Fig. 48.1 Algorithm for management of colonic strictures. *Medical therapy for diverticular disease includes antibiotics (IV or oral), bowel rest, and adequate fluid resuscitation; +Medical therapy for IBD includes steroids, biologic agents, and other anti-inflammatory medications; &Medical therapy for infectious diseases includes targeted antibiotics/antivirals, bowel rest, and adequate fluid resuscitation

rate (ESR) and c-reactive protein (CRP) can be obtained to evaluate the degree of inflammatory response and to monitor treatment response against baseline. Stool cultures for Salmonella, Shigella, Campylobacter, Escherichia coli (E. coli) 0157:H7, Clostridium difficile (C. diff), and viruses such as cytomegalovirus (CMV) should be obtained if patients are immunocompromised, or have recent history of travel, hospital or institutional stay, or antibiotic use.

D. Imaging should be obtained as part of the initial assessment to differentiate proximal and distal locations. Abdominopelvic computed tomography (CT) with oral and intravenous contrast highlights the degree of bowel wall attenuation, bowel wall thickness, symmetry of thickness, and length of affected colon. In many situations, CT scans will provide insight into the underlying etiology of the stricture, particularly for non-infectious causes. CT scans have approximately

93–98% sensitivity and 75–100% specificity in detecting diverticulitis. Pericolonic inflammation with >10 cm of involvement and preservation of mucosal lining are the most important criteria in differentiating acute and chronic diverticulitis from neoplasm. However, in approximately 10% of cases, diverticular strictures cannot be reliably distinguished from stenosing neoplasm due to overlapping CT features. Colonoscopy is the preferred modality for direct evaluation of colonic pathology as it allows visualization of the stricture to identify intraluminal or extraluminal pathology. If an intraluminal lesion is seen, multiple biopsies should be obtained to assist with diagnosis. Contraindications to colonoscopy may include suspected perforation or medical instability. While complete evaluation of the colon is preferred, 5–15% of colonic strictures cannot be traversed with a colonoscope. If unable to pass the stenotic region, double contrast barium enema may provide additional information regarding lumen size and degree of obstruction (Fig. 48.2). Magnetic Resonance Enterography (MRE) has an important role in defining bowel anatomy, particularly in inflammatory bowel disease (IBD), where diagnosis of disease-related complications is reported with sensitivity 75–100% and specificity 91–100%.

Fig. 48.2 Barium enema, rectal stricture black arrow points to stricture

E. Benign etiologies of colonic stricture include diverticular disease, IBD, ischemia, infection, and sequelae of congenital pathology. In North American adults the most common cause of benign colonic stricture is diverticular disease, followed by Crohn's disease, ischemic colitis, and radiation colitis. In the pediatric population, CMV and hemolytic uremic syndrome (HUS) caused by E. coli O-157 infection have resulted in numerous case reports of colon strictures. Congenital causes for stricture include neonatal necrotizing enterocolitis, or rarely colonic atresia or stenosis. Cystic fibrosis has been linked to the development of colonic strictures.

F. In the western hemisphere, diverticulosis occurs in approximately 10–30% of the population >50 years old and 30–60% of the population >80 years old although most remain asymptomatic. In western countries, 95% of cases of acute diverticulitis are identified in the left colon and sigmoid, while in Asian countries up to 70% of disease is reported in the right colon. Diverticular disease-related colonic obstruction occurs in about 10% of patients. Hinchey classification for diverticulitis (Table 48.1) highlights the four stages. Stricture/obstruction can occur in any of the four stages but is most often seen in complicated diverticulitis stage II or above. Symptoms of diverticular stricture include persistent alteration in bowel function after resolution of the acute diverticulitis flare, with abdominal pain, bloating, and intolerance of high fiber foods often reported by patients. Relief of symptoms is often

Table 48.1 Hinchey classification for diverticulitis

Stage I	Stage II	Stage III	Stage IV
Paracolic abscess confined to mesentery of colon	Distant abscess in pelvis or retroperitoneum	Purulent peritonitis	Feculent peritonitis

See Touzios & Dozios 2009.

reported with soft/liquid diets and use of laxatives, and occasionally with use of antispasmodic medications. Colonoscopy is essential in confirming the diagnosis and delineating the degree of obstruction.

G. Strictures often occur in Crohn's disease (CD) secondary to prolonged inflammation and fibrosis, but raise concern for underlying neoplasm. In contrast, all strictures in ulcerative colitis (UC) should be considered dysplastic or neoplastic. Approximately 60% of patients with Crohn's disease suffer from colonic involvement, however, the North American and European incidence of colonic strictures in UC and CD is reported to be 5–17% and 5%, respectively. Strictures in IBD are classified as either inflammatory or fibro-stenotic lesions. The type of stenosis determines first course of treatment: inflammatory lesions are typically managed medically, while fibro-stenotic lesions may undergo endoscopic dilation or proceed to surgical evaluation. Regardless of the underlying etiology, IBD strictures always carry concern for neoplasm, even if the biopsies are negative or inconclusive. Cancer is identified in surgically resected colorectal stricture for 0.8% of CD patients and 5% of UC patients, and results in 15% of all IBD deaths.

H. Ischemic strictures in the colon can be caused by non-occlusive ischemic disease, arterial occlusive, and venous occlusive disease. Colonic stricture occurs in 10–15% of cases of ischemic colitis. Ischemia results from an acute self-limited compromise in intestinal blood flow. Non-occlusive ischemic disease can result from hypovolemic states due to congestive heart failure, transient hypotension in the perioperative period, or shock due to sepsis or hemorrhage which can result in hypo-perfusion. In arterial occlusive disease, mesenteric artery emboli, thrombus, or trauma may lead to interruption of blood flow and decreased colonic perfusion. Obstructed outflow in venous occlusive disease leads to congestion. Strictures typically develop in patients >70 years old with heart disease usually associated with diffuse disease in small segmental mesenteric vessels that predisposes to mal-perfusion. Watershed regions in the colon at the splenic flexure, the region between the superior and inferior mesenteric artery distributions, and the recto-sigmoid artery distribution are especially vulnerable due to limited collateral flow.

I. Infectious colonic strictures can occur in the setting of ileocecal tuberculosis, lymphogranuloma venereum, colonic CMV, and a number of amebic and filarial parasitic infections. Although rare, hemolytic uremic syndrome (HUS) caused by Escherichia coli O–157 can result in stricture formation during the post-acute phase of HUS, with estimated 3% incidence. CMV colitis typically occurs in immunocompromised patients. However, CMV related colitis has been reported in up to 10–27% of immunocompetent patients requiring urgent colectomy, especially in those >55 years old. However, these patients typically have IBD, with only a few case reports available describing CMV-associated colonic stenosis affecting non-IBD immunocompetent patients.

J. Malignancy is a crucial diagnosis to consider when evaluating colonic strictures. Colorectal cancer is the second leading cause of cancer death in the United States. Strictures as a result of an underlying neoplasm are the leading cause of large bowel obstruction in the U.S. population, ranging from 30–60% of all significant obstructions, the majority of which occur in the sigmoid region. Metastatic lesions to the colon should be considered when multiple strictures are identified.

K. Iatrogenic causes of colonic stricture include radiation treatment for cancer and anastomotic complications from a prior operation. Bowel segments exposed to external beam radiation or brachytherapy are susceptible to obliterative endarteritis due to radiation injury, leading to increased wall thickness and luminal narrowing. The rectum is the most common site of injury despite its relative resistance to radiation injury due to its fixed position and therefore more consistent expo-

sure. Technical elements of colorectal anastomosis may also predispose to stricture formation. A Cochrane review based on seven studies (1042 patients) shows increased frequency of stricture formation in stapled anastomosis at 8% versus 2% of hand-sewn anastomosis. Complications of anastomotic healing, including ischemia and anastomotic leak, can contribute to stricture development.

L. Treatment varies based on the underlying etiology but options include medical management, endoscopic therapies, and surgical interventions. Asymptomatic benign colonic strictures, particularly ischemic or infectious, may resolve without specific therapy within 12–24 months. Therefore, symptoms should be used to guide the decision to intervene beyond observation. In the specific case of IBD-related inflammatory strictures, medical therapies include steroids, 5-aminosalicylates, immunomodulators, and anti-TNF therapies. However, in the setting of fibrotic strictures, medical therapies are ineffective and more likely to require endoscopic or surgical treatment once the acute inflammatory flare is temporized. Endoscopic balloon dilations for IBD-associated strictures can be employed, and repeat dilations are often required. Self-expanding colonic stents can be used for a variety of indications, including malignant and diverticular strictures. Stenting is often most successful with sigmoid or left sided lesions. Although there is a 90% technical success rate with stent placement, complications can include stent migration (40%) and perforation (20%). In malignant cases, perforation can result in higher loco-regional recurrence, altered pathology, and tumor cell dissemination. Given the frequency of complications, stenting is typically used as a bridge to surgery, allowing for temporary decompression and bowel preparation, with subsequent single-stage resection without diversion. Stenting only serves as definitive therapy for advanced malignancy or patients with medical problems prohibiting more aggressive intervention. In these settings, stents serve an important role in providing palliative relief of symptoms and improving patient quality of life. For strictures arising from metastatic disease, often with long, multifocal diseased segments associated with external compression, stent failure rate has been reported as high as 60%. Stents have been successful in up to 80% of transverse colonic strictures due to gastric cancer compression.

M. Surgical intervention is indicated for known or suspected malignancy, or for strictures refractory to other treatment methods. Colonic strictures should be treated with segmental resection, maintaining oncologic principles of appropriate margins, blood supply ligation, and lymph node harvest. Stricturoplasty is generally contraindicated in the treatment of colonic strictures, but may be considered in rare instances of short segment stricture. If the patient is not fit for definitive surgical intervention, diversion via laparoscopic or open approach may be used to relieve obstruction and minimize the morbidity of potential perforation. Barriers to definitive surgical intervention, such as malnutrition, infection, and glycemic control, should be addressed preoperatively in order to optimize the patient for future definitive surgical management.

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49 Acute Colonic Pseudo-Obstruction (ACPO): Ogilvie's Syndrome

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Refer to Algorithm in Fig. 49.1

A. Overview

Acute colonic pseudo-obstruction (ACPO) was first described by Sir Heneage Ogilvie in a 1948 report of two patients who presented with signs and symptoms of colonic obstruction without evidence of any organic disease. As both patients were found to have malignant masses invading the celiac plexus, he hypothesized that the tumors had disrupted the sympathetic innervation to the intestine. Since this initial description, many series of the phenomenon have been published, and ACPO is now a well-recognized clinical entity. Currently, ACPO is defined as massive colonic dilatation in the absence of mechanical obstruction.

The etiology of ACPO is incompletely characterized but is still thought to be due to autonomic dysregulation of the colon causing unopposed parasympathetic stimulation. Although ACPO is idiopathic in some patients, the vast majority of patients have underlying conditions that predispose them to ACPO. These conditions include trauma, surgery, infection, malignancy, cardiopulmonary conditions, and others. Electrolyte disturbances and medications can be instigating factors; familiar precipitators are opioids and calcium channel blockers. A 2011 study using the National Inpatient Sample (NIS) found the incidence of ACPO to be 105 cases per 100,000 hospitalizations.

ACPO affects both men and women, but there is a small preponderance in men. Patients present typically in the fifth or sixth decade of life. As described, these patients usually have a predisposing condition, and for surgical patients, present on average between post-operative days 4 and 5. Signs and symptoms can include nausea and vomiting, abdominal pain, constipation, diarrhea, fever, abdominal pain and distention. Abdominal pain and distention are usually the chief findings. Ischemia and perforation are the feared complications of ACPO, and avoidance of these drives management. Fever and leukocytosis are worrisome for ischemia or perforation. Reports of perforation vary from 3–15%.

B. Evaluation and Diagnosis

The diagnosis of ACPO is made on the basis of clinical and radiographic findings. The evaluation should consist of a complete history and physical examination. All medica-

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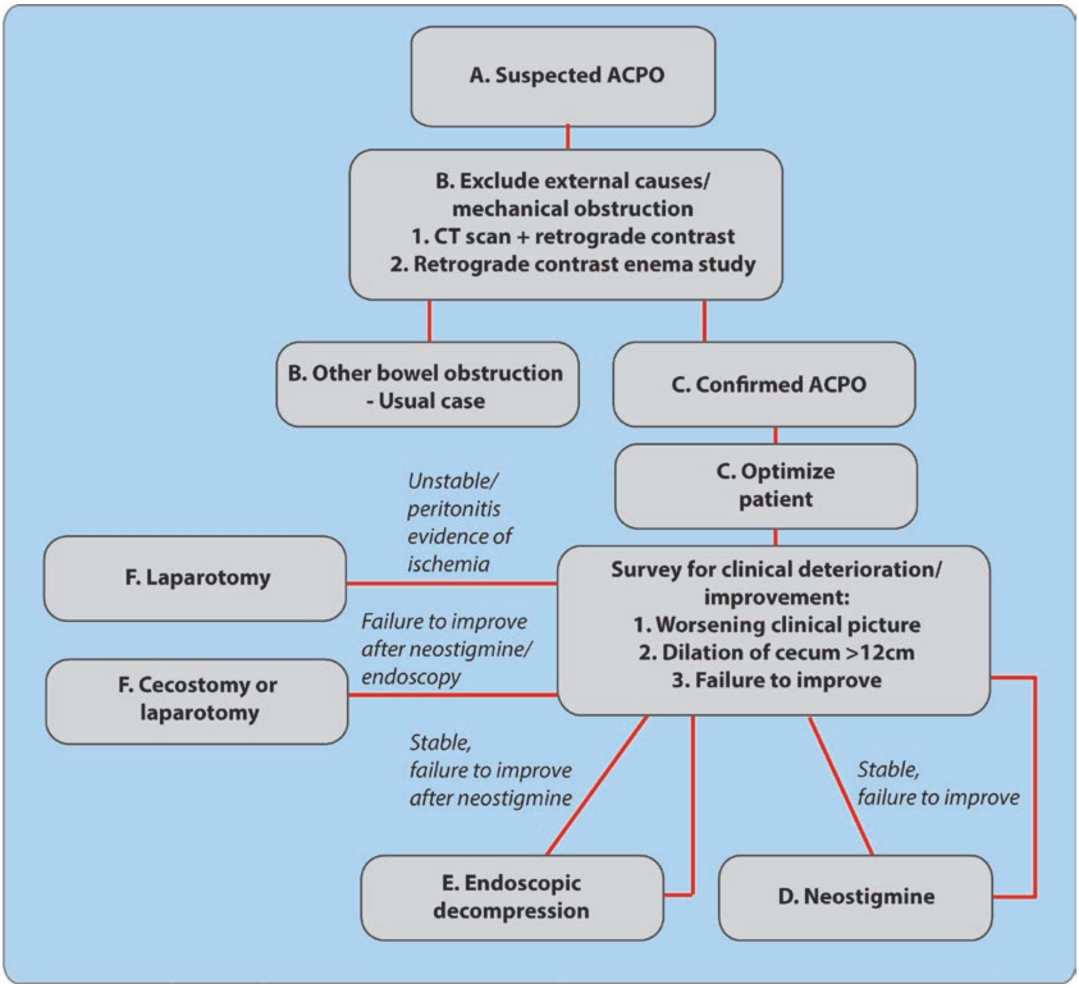

Fig. 49.1 Algorithm for evaluation and management of ACPO

tions, including non-prescription medications, should be reviewed. Every attempt should be made to immediately discontinue all narcotics. Laboratory investigation is obtained to evaluate for leukocytosis, acidosis, renal insufficiency, and electrolyte disturbances such as hypokalemia or hypocalcemia. Leukocytosis and/or acidosis indicate possible perforation and/or ischemia and should prompt intervention.

Plain radiographs of patients with ACPO will show gaseous distention of the colon, either throughout the colon, or sometimes with a cutoff at the splenic flexure with proximal dilatation. It is essential to distinguish between mechanical obstruction and ACPO; ACPO should be a diagnosis of exclusion. This goal can be accomplished with either abdominal computed tomography (CT) or water soluble contrast enema. CT is beneficial as it provides additional extra-colonic information. The exam can be performed without contrast, but enteral contrast is helpful to delineate the bowel lumen; retrograde is the preference of the authors. Once mechanical obstruction is excluded and the diagnosis of ACPO made, plain radiographs and serial examination can be used to follow patients.

The cecum is most susceptible to perforation based on LaPlace's law of wall tension. Risk factors for perforation can be judged

based on the diameter of the cecum and duration of dilation. In one of the largest reported series, the rate of perforation was zero when the cecum was less than 12 cm, but rose to 7% at 12 cm, and almost 25% at 14 cm or greater. Duration of dilation is also a risk factor for perforation; in this same study, the mortality based on delay in decompression from time of diagnosis for <4 days, 4–7 days and >7 days was 15%, 27%, and 73% respectively. Another study showed higher perforation rates when dilation had been present for more than 2 days. Therefore, in the absence of physiologic or laboratory concern for ischemia or perforation, intervention should typically be undertaken when cecal diameter is 12 cm or greater, and/or dilation has been present for more than 2–3 days.

C. Optimization/Non-operative Management

Once the diagnosis of ACPO has been established, the management is well established. The vast majority of patients with ACPO (over 75%) will improve with conservative measures alone directed at decompression and restoration of colonic motility (Table 49.1). These steps consist first of bowel rest and decompression. A large bore urinary catheter (20 French) with holes cut in the side in the manner of a chest tube should be inserted into the rectum and connected to straight drainage. Nasogastric tube decompression is useful to eliminate swallowed air as best as possible.

The patient's medications should be carefully reviewed and medications that alter bowel motility, such as opioids or calcium channel blockers, should be stopped or their doses minimized. Enlisting the help of a pharmacist can be very useful in these cases. Opioid pain relievers are common precipitating factors in surgical patients. Again, every effort should be used to achieve pain control with non-opioid medication. Options include acetaminophen (especially now that an intravenous preparation is available), ketorolac if renal function will permit, regional anesthetics, or transdermal patches.

Electrolytes should be aggressively supplemented to achieve normal levels. Patients should be mobilized out of bed; ideally to walking. If walking is not possible, patients should sit in a chair; failing this, patients should be turned frequently and the knee-chest position may be attempted. Underlying conditions, such as infection, should be treated.

While treating patients with ACPO with conservative measures, daily abdominal radiographs should be obtained to evaluate the diameter of the cecum. Additionally, the duration of distention should be tracked. If these measures fail to provide clinical and radiographic improvement within 2–3 days, or the cecal diameter approaches 12 cm, more aggressive measures should be undertaken.

Table 49.1 Non-operative measures for ACPO

Non-operative measures
• Nothing per mouth
• Nasogastric decompression (minimize swallowed air reaching colon)
• Rectal decompression with rectal tube (large urinary catheter with holes cut in side)
• Aggressively correct electrolyte imbalances
• Limit or stop offending medications
– Review medications with pharmacist
– For surgical patients, use non-opioid pain medication as much as possible
• Mobilize patient out of bed
– Ambulate
– Out of bed to chair if unable to walk
– If unable to be out of bed, turn frequently and use knee-chest position if possible
• Treat underlying conditions

D. Pharmacologic Stimulation (Neostigmine)

Neostigmine is an acetylcholinesterase inhibitor administered intravenously as a stimulatory agent. Neostigmine was shown to be effective in a small randomized clinical trial published in 1999. Ten of eleven patients receiving neostigmine experienced immediate improvement in symptoms and distention within minutes. Two of the responders recurred and required further intervention. None of the ten patients who received placebo had an immediate clinical response. Other non-randomized studies have been performed with similar results. The side

Table 49.2 Neostigmine for ACPO

Neostigmine administration
• Ensure no contraindication – Bronchospasm, arrhythmias major contraindications • Move patient to monitored setting with telemetry and frequent vital sign measurement • Atropine at bedside to treat symptomatic bradycardia • Give 2 mg of neostigmine as infusion over 5 min • If no response within 30 min, give second infusion of 2 mg • The patient should remain monitored for at least 30 min after infusion(s)

Table 49.3 Endoscopic decompression in ACPO

Tips	Tools
• Should be performed by experienced endoscopist • Use benzodiazepines alone for sedation • No prep is needed • Minimize insufflation • Liberal use of suction • Advance colonoscope beyond splenic flexure • Leave long rectal decompression tube • Stop and proceed to operation if mucosal ischemia seen	• Best colonoscopic options – Large therapeutic channel – Dual channel • Decompression tubes – Vary in diameter and length based on commercial kit used

effects of neostigmine include bradycardia, excessive salivation, abdominal pain and vomiting.

Neostigmine should be administered in a monitored setting with telemetry and frequent vital sign measurement (Table 49.2). An infusion of 2 mg of neostigmine is given over 5 min and the patient monitored by the physician for improvement. If there is no response within 30 min, a second dose of 2 mg of neostigmine may be given. As bradycardia can be clinically significant, atropine must be available at the bedside for symptomatic bradycardia. If the patient shows no response after two doses, endoscopic decompression should be initiated.

E. Endoscopic Decompression

Endoscopic decompression for ACPO was first introduced in 1977. Prior to this, patients for whom other measures had failed had been managed operatively. Endoscopic decompression has been reported in many studies to be safe, although it is technically challenging in these patients. This technique is the established next line of management if an experienced endoscopist is available. Decompression can be achieved with colonoscopy alone or with colonoscopy and placement of decompression tube (Table 49.3). Perforation, the major complication of decompressive colonoscopy, is low in reported series (as low as 2%).

Benzodiazepines alone should be used for sedation to avoid opioid exacerbation of colonic inertia. A bowel prep is unnecessary as the colonic dilatation facilitates colonoscopic advancement over feces without difficulty in almost all cases. The colonoscope should be advanced using as little insufflation as possible and liberal suction should be used for both stool and air. Little is known regarding the benefit of carbon dioxide insufflation versus air. Decompression is achieved by advancing the colonoscope past the splenic flexure, but it is not necessary to advance all the way to the cecum.

In several series, successful decompression with immediate clinical and radiographic improvement has been reported in approximately 60–85% of cases. However, recurrence can be as high as 45% and varies in time to recurrence. In one study, the mean time to recurrence was 3.7 days (range 1–8 days). Placement of a long rectal tube during decompressive colonoscopy has been shown to significantly decrease recurrence rate versus colonoscopy alone. If recurrence does occur and the patient remains non-toxic, colonoscopy may be attempted again. There is debate regarding what to do if mucosal ischemia is seen and there are few data to guide decision making. The authors recommend starting antibiotics and proceeding to surgery if the patients develop recurrent symptoms after two colonoscopies or ischemia is seen.

F. Definitive Decompression

Definitive decompression is required in a small percentage of patients for whom neostigmine was either contraindicated or failed and endoscopic decompression failed.

For non-toxic patients without evidence for ischemia or perforation, either percutaneous

or open cecostomy may be considered. These procedures have been reported to be successful in small series of patients. However, cecostomy is an infrequently performed procedure and may become a legacy technique.

If laparotomy is planned, factors dictating management include the length and section of involved bowel, presence of perforation or ischemia, and surgeon experience. Mortality for patients requiring surgery ranged from 12% to 15% in the 2011 NIS study, but has been reported previously to be as high as 35–60%. In the case of suspected perforation or ischemia, bowel resection and proximal diversion is the standard. The distal bowel can either be managed with a long Hartmann's pouch or as part of a Prasad ileostomy; the Prasad ileostomy technique will assist with reversal in the future. In the absence of perforation or ischemia, options for management vary and include partial colectomy, almost always including the right colon, with or without diversion, total colectomy and ileostomy, and ileostomy. Given the high mortality rates associated with laparotomy, diversion is safest. The ileostomy may be an end, Prasad, or loop, although little has been written about loop ileostomy in this setting.

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Colonic Conditions: Irritable Bowel Syndrome (IBS)

50

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Introduction

Irritable bowel syndrome (IBS) is a chronic functional disorder characterized by abdominal pain and altered bowel habits in the absence of an organic cause to explain these symptoms. IBS may be divided into subtypes, including IBS with diarrhea, IBS with constipation, IBS with mixed bowel habits, alternating IBS, post infectious IBS, and unspecified IBS (refer to Table 50.1). Various factors are thought to contribute to the pathology of IBS and include changes to the gut microbiome, intestinal permeability, gut immune function, motility, visceral sensation, brain-gut interactions, and psychosocial state. There appears to be a genetic component, as genetic polymorphisms have recently been associated with the development of IBS. Alterations in the innate immune system have been demonstrated in patients with IBS and are hypothesized to contribute to the development of IBS. IBS is one of the most commonly encountered medical conditions, with a worldwide prevalence of 10–15%. It is also one of the costliest medical conditions with an estimated cost of $21 billion to the United States yearly. Younger patients and women are more likely to be diagnosed with IBS, with a female to male ratio of 2:1. The most common age at diagnosis is between 30 and 50 years of age. The prevalence of IBS is equal among Caucasians and African Americans and may be lower in Hispanics. Other functional bowel disorders such as functional dyspepsia, pain disorders including fibromyalgia, chronic pain, interstitial cystitis and psychological conditions inclusive of anxiety, somatization are often seen in patients with IBS and are more prevalent than in the general population.

Table 50.1 Classification of IBS subtypes

• IBS with constipation: hard stools ≥25%, loose stools <25%
• IBS with diarrhea: loose stools ≥25%, hard stools <25%
• IBS with mixed symptoms: hard stools ≥25%, loose stools ≥25%
• Undefined IBS: absence of sufficient abnormality in stool consistency
• IBS with alternating symptoms: symptom fluctuance over time

Refer to Algorithm in Fig. 50.1

A. Abdominal discomfort or pain with an alteration in bowel habits are the classic symptoms described in patients with IBS. The abdominal pain is often diffuse, intermittent and crampy in nature. The alterations in bowel habits may include diarrhea, constipation or both. Other symptoms that many patients experience include bloating, urgency, and relief of pain after defecation.

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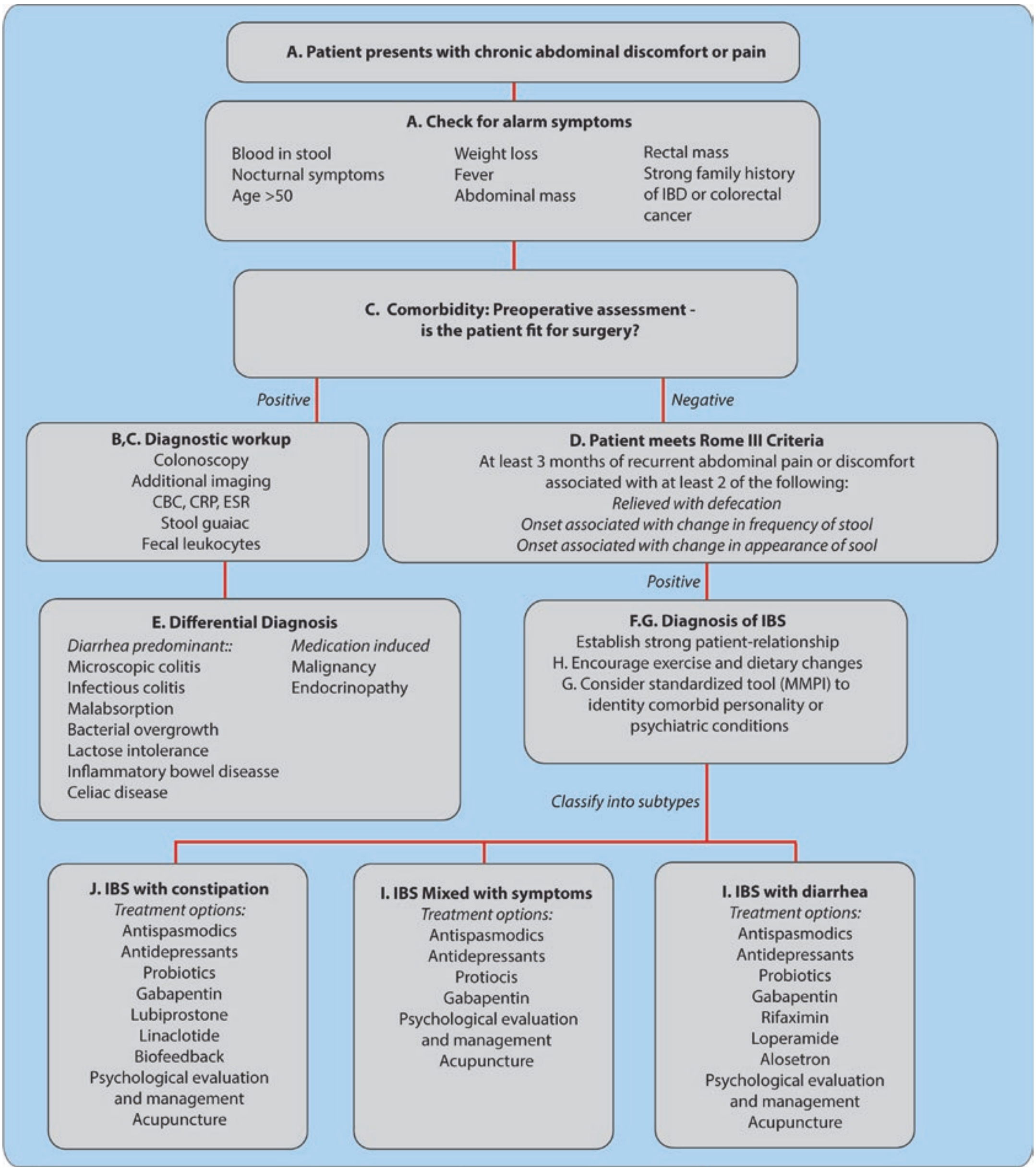

Fig. 50.1 Algorithm diagnostic workup and treatment of irritable bowel syndrome

It has been demonstrated that patients with IBS are more likely to have additional co-morbid conditions, as high as 50%. In particular, functional dyspepsia and GERD have a high prevalence among patients with IBS.– associated extra-intestinal complaints may include fatigue, headache, musculoskeletal pain, pelvic pain and impaired sleep. Alarm symptoms are symptoms that should alert the clinician that an organic cause for symptoms should be sought out. These include weight loss, blood in the stool, fever, pain that awakens one from sleep, and age greater than 50.

B. The diagnosis of IBS can be challenging and frustrating for the clinician. Patients with IBS usually present to a physician with a host of nonspecific complaints. Performing a thorough history, physical exam and utilizing selected tests to exclude various organic causes are essential to the diagnosis of IBS. Clinicians should consider the diagnosis of IBS if a patient reports abdominal pain or discomfort, bloating and a change in bowel habits for greater than 6 months. Targeted questions regarding alarm symptoms should be asked and an alternative diagnosis should be sought out if present. Any of the following physical signs should alert the clinician to a possible alternative diagnosis, anemia, blood on rectal exam, palpable abdominal or rectal masses.

C. Many factors are thought to increase the risk of developing IBS, the most well documented is post-infectious IBS. Post-infectious IBS is a subtype that occurs after development of gastroenteritis, most commonly with salmonella, campylobacter, shigella or giardia. The risk of developing IBS with exposure to acute gastroenteritis has been estimated at 5–32%. IBS has been shown to cluster in families, with an increased risk of two- to threefold if a relative is diagnosed with IBS. Other risk factors include recent antibiotic use, history of childhood abuse, and having a low birth weight.

D. The Rome III criteria can be utilized to help diagnose patients with IBS (Table 50.2).

E. The differential diagnosis for irritable bowel syndrome is broad and varies according to the subtype. In patients with diarrhea-predominant, these include microscopic colitis, infectious colitis, malabsorption, bacterial overgrowth, lactose intolerance, ulcerative colitis, Crohn's disease, and Celiac disease. The differential for constipation and mixed type include medication induced, malignancy and endocrinopathies.

Table 50.2 Rome III diagnostic criteria for irritable bowel syndrome (IBS)

• At least 3 months, with onset at least 6 months previously of recurrent abdominal pain or discomfort associated with two or more of the following:
– Relieved with defecation and/or
– Onset associated with a change in frequency of stool and/or
– Onset associated with a change in appearance of stool

F. The role of diagnostic testing in patients with IBS should be targeted and begin with a careful history and physical examination. Patients with alarm symptoms, signs or strong family histories of colorectal cancer, inflammatory bowel disease, or celiac disease should prompt the clinician to investigate causes other than IBS. Basic lab work including CBC, ESR, and CRP can help exclude inflammatory bowel disease. In patients with diarrhea-predominant IBS, stool studies and fecal fat testing can help to rule out infectious and malabsorptive etiologies. Tissue Transglutaminase IgA can be obtained if celiac disease is a concern. The role of imaging studies is limited in patients with IBS and should be considered if organic pathology is in the differential. In patients that are anemic or older than 50 years of age, a colonoscopy should be performed to exclude malignancy. In addition, endoscopy may be used in IBS diarrhea predominant patients to exclude microscopic colitis as a cause of the diarrhea with a mucosal biopsy.

G. It has long been recognized that a significant proportion of patients with IBS have associated psychiatric illness and personality pathology. Multiple standard psychometric instruments have been utilized to evaluate anxiety and depression as well as personality characteristics in patients with IBS, including Hamilton anxiety scale, Beck depression scale, State-Trait Anxiety Inventory (STAI), Minnesota Multiphasic Personality Inventory (MMPI), and Eysenck Personality Inventory. Recent studies have demonstrated a significant difference in scores between patients with IBS compared to healthy controls. In addition, it has been shown in various randomized clinical trials that dietary, lifestyle, medical, and behavioral modifications are effective in the treatment of irritable bowel syndrome. It is clear that a strong patient-physician relationship is an important com-

ponent in the care of patients with IBS and decreases health care visits.

H. Dietary and lifestyle modifications have been shown to be effective in patients with IBS. In particular, a high fiber diet has been shown to improve symptoms. Recently, there has been a growing interest in fermentable oligosaccharides, disaccharides, monosaccharides and polyols (FODMAPs) as they relate to IBS symptoms. FODMAPs are poorly absorbed short chain fatty acids such as fructose and lactose. Evidence suggests that intake of FODMAPs increase GI symptoms in patients with IBS, and studies have shown significant symptom reduction with a low FODMAP diet. Physical activity has also been shown to reduce symptoms and symptom severity in patients with IBS.

I. In many patients with IBS the goal of therapy is symptom reduction. Antispasmodic agents have been shown to reduce symptom severity when compared to placebo. Antidepressants such as Tricyclic antidepressants (TCAs) and SSRIs, have been shown in some series to improve symptoms. Although, other studies have shown no benefit between TCAs and SSRIs when compared to placebo. The benefit of antidepressants remains to be elucidated. Other therapies such as probiotics and neuropathic agents are often used to treat IBS. Gabapentin was shown to reduce symptom thresholds in patients with IBS and studies have shown that probiotics improve abdominal pain and flatulence when compared to placebo.

J. Specific agents have shown efficacy in the subtypes of IBS and include antidepressants and serotonin antagonists. Amitiza® (Lubiprostone) a chloride channel activator and Linzess® (Linaclotide), a Guanylate cyclase agonist, have been FDA approved for treatment in patients with IBS-C subtype. In a recent meta-analysis, Amitiza® was found to decrease the severity of constipation, improve the consistency of stool, decrease degree of straining and degree of abdominal bloating compared to placebo in patients with IBS-C. Linzess® has been shown to decrease abdominal pain, discomfort, bloating and fullness when compared to placebo in patients with IBS-C. In patients with IBS-D subtypes, Rifaximin, Loperamide, and Alosetron have been shown to improve symptoms. In particular, Alosetron was shown to improve quality of life scores and bowel function, in patients with diarrhea predominant IBS. Rifaximin improved abdominal pain, bloating and loose stools when compared to placebo in a double-blind randomized control trial.

K. Alternative therapies have been utilized for the treatment of IBS including acupuncture, biofeedback and psychotherapy. Acupuncture has been shown to be associated with greater symptom improvement than standard pharmacologic treatment in multiple RCTs. Psychotherapy has been shown to have an impact in the treatment of IBS. In one study, psychotherapy was delivered in ten sessions and focused on coping mechanisms and resolving emotional problems. Psychotherapy was found to relieve abdominal pain and bowel dysfunction more than medical therapy alone. Biofeedback has recently been shown to improve abdominal pain and bloating in patients with IBS-C, when delivered consistently.

L. As a functional disease, surgery has had a limited role in the management of IBS patients, yet a high surgical rate exists in these patients. Patients with IBS have a higher rate of cholecystectomy, appendectomy, hysterectomy, colon resection, and back surgery than those without IBS. Newer minimally invasive procedures such as sacral nerve stimulation (SNS) may be of use in highly selected patients with IBS refractory to conservative management. However, IBS is not an FDA labeled indication for SNS. In one small randomized, crossover control trial, sacral nerve stimulation was shown to improve pain, bloating, diarrhea, constipation, and satiety. In addition, SNS improved quality of life endpoints including, sleep, emotional distress, eating habits, fatigue and impaired daily activity. The mechanism of symptom improvement with SNS has yet to be fully explained, but it has been shown that SNS relaxes the rectal wall, making the rectal

wall more sensitive to stretch and less sensitive to cold. Decreased rectal wall stiffness has been associated with symptomatic relief. Additional studies are needed to further elucidate the efficacy and safety of sacral nerve stimulation as a therapy for patients with IBS.

M. IBS is a chronic relapsing disorder that can greatly affect the quality of life of patients, but studies have shown no increase in mortality when compared to patients without IBS. In addition, when followed over the long term, very few patients are found to have an organic cause of their symptoms. Patients with IBS have been shown to have lower quality of life scores when compared to healthy subjects, with scores similar to other chronic disorders such as GERD and diabetes. However, quality of life scores have been shown to increase when proper therapeutic treatments were initiated.

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51

Colorectal Trauma

Sean C. Glasgow and Fia Yi

Colon Trauma Refer to Algorithm in Fig. 51.1

A. Trauma to the colon is almost always the result of penetrating mechanisms such as stabbings or gunshot wounds, with the transverse colon being most prone to injury. The diagnosis of blunt colonic trauma requires a high-degree of suspicion. For either mechanism, CT scanning remains the most sensitive test. Findings of extraluminal gas, significant free fluid, bowel wall thickening, segmental loss of contrast enhancement, contrast extravasation from the mesentery, or location adjacent to suspected bullet trajectory all suggest a potential colon injury (Fig. 51.2). Although some patients with low-velocity penetrating abdominal trauma may treated with serial examinations or diagnostic laparoscopy, patients with frank peritoneal signs or the above CT findings should undergo prompt exploratory laparotomy following initial resuscitation and evaluation.

B. While the Organ Injury Scale (Table 51.1) offers precise classification, generally speaking, colon trauma can be viewed as either destructive or non-destructive. The latter encompasses grade I and II injuries, and includes serosal tears without lumen perforation, hematomas resulting from projectile cavitation, and simple perforations involving less than half the circumference of the bowel wall. Non-destructive wounds occur more commonly in low-velocity penetrating trauma.

C. Primary repair of non-destructive colon wounds has been shown conclusively to be safe and results in fewer infectious complications than routine fecal diversion. Importantly, primary repair includes either simple suture repair or resection with primary anastomosis. Suture repairs are generally performed in two layers, with the first layer achieving approximation of healthy mucosa (limited debridement of wound edges may be indicated) and the second layer of Lembert sutures ensuring complete inversion of the closure. Traditionally, left-sided colon trauma was more frequently diverted than repaired relative to right-sided injuries. However, several studies have shown no difference in leak or complication rates based on anatomic area of injury. The fundamental surgical aspects of ensuring healthy, well-perfused, and tension-free bowel in the repair remain key.

D. Destructive colon injuries often occur following high-velocity penetrating trauma or major deceleration mechanisms. These injuries will

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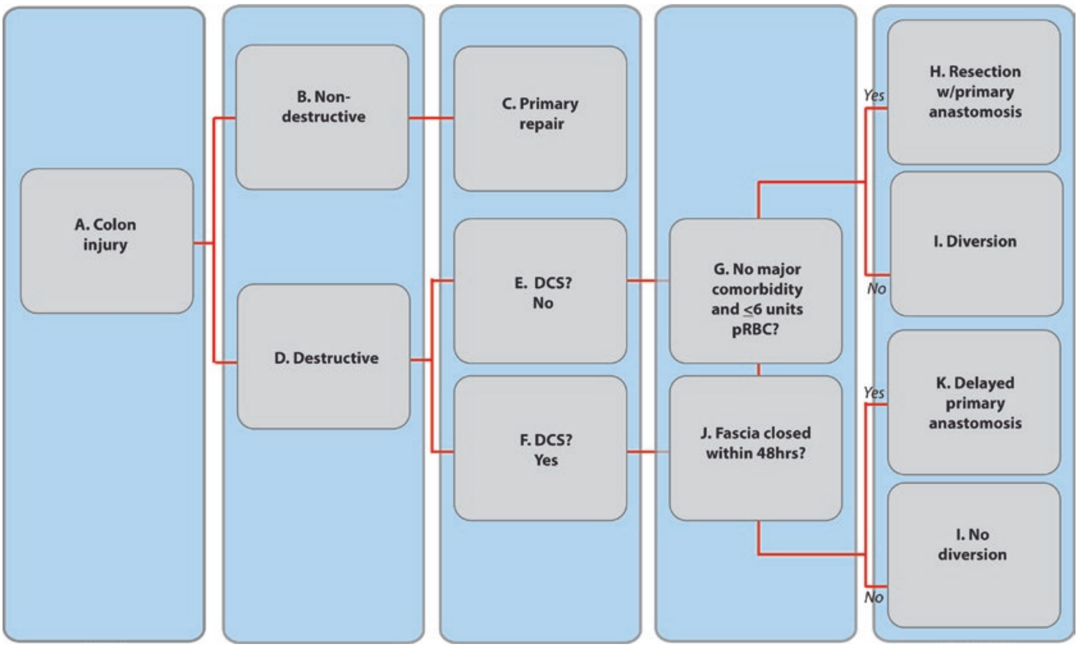

Fig. 51.1 Algorithm for managing colon trauma. *DCS* damage control surgery, *pRBC* packed red blood cells, *hrs* hours

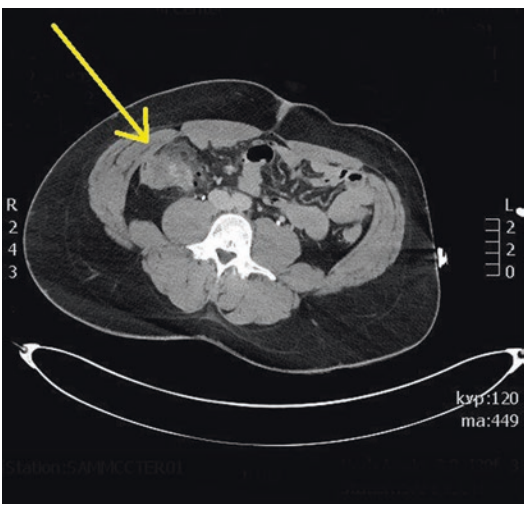

Fig. 51.2 CT image showing extraluminal gas and bowel wall thickening, suggestive of right-sided colonic injury following transabdominal gunshot wound

Table 51.1 Colon Injury Scale

Grade	Type of injury	Description
I	Hematoma	Contusion or hematoma with devascularization
	Laceration	Partial thickness, no perforation
II	Laceration	Laceration <50% of circumference
III	Laceration	Laceration ≥50% of circumference without transection
IV	Laceration	Transection of the colon
V	Laceration	Transection of the colon with segmental tissue loss
	Vascular	Devascularized segment

Colon injury scale, adapted from Moore et al.

always require at least segmental colon resection in order to control hemorrhage and fecal spillage. Injury to multiple intra-abdominal organs is likely. Initial steps following generous laparotomy are four-quadrant packing with surgical sponges, careful clamping of obvious bleeding vessels, and rapid closure of open bowel injuries using Babcock clamps, umbilical tape, or GIA staplers to control contamination.

E. While there is no level I evidence supporting the use of damage control surgical (DCS) techniques, the perceived benefits of DCS following major abdominal trauma are clear. The goals of DCS are to control active hemorrhage

and limit on-going gastrointestinal spillage in a rapid manner, thereby allowing active resuscitation and correction of acid-base and coagulation disorders. After initial surgical measures, the abdomen is closed temporarily using a vacuum-type dressing and the patient is moved to the intensive care unit for further care. Reconstructive efforts such as enteric anastomoses are deferred until the patient is more stable and typically performed at a second operation in 24–48 h after initial laparotomy.

F. Many factors influence the surgeon's decision on whether to perform DCS. These may include: (a) metabolic derangement [e.g. hypothermia, pH < 7.2, elevated INR or abnormal thromboelastogram (TEG)], (b) injury-specific factors such Injury Severity Scale (ISS) over 25, injury to multiple body regions, blast or high-velocity wounds, (c) sustained hemodynamic instability or massive transfusion requirement, (d) environment-specific factors such as surgeon experience and institutional capabilities. If DCS is selected, any colon wounds should be expeditiously closed using GIA or TA staplers to limit on-going peritoneal contamination. Limited peritoneal irrigation with warm saline is done to remove gross fecal spillage. Segmental resection of clearly necrotic or destroyed segments may be performed quickly. Active bleeding from the mesentery should be oversewn but is not an absolute indication for colectomy at the initial operation. No attempt at anastomosis or ostomy should be made; the bowel may be safely left in discontinuity for up to 72 h, though a secondary evaluation at 12–24 h is often performed.

G. Largely based on extensive study from the University of Tennessee in Memphis, major co-morbidities and an intraoperative transfusion requirement greater than 6 units of packed red blood cells (RBCs) have consistently been shown to increase anastomotic leak in colon trauma patients (upwards of 40%). Although patient co-morbidities may not be immediately known upon presentation to the emergency room following trauma, suspicion of cirrhosis, congestive heart failure, poorly controlled diabetes or other significant disease should lead the surgeon to favor fecal diversion. Significant transfusion requirement, whether due to intra-abdominal or other hemorrhage, remains a contraindication for primary anastomosis out of concern for hypoperfusion.

H. Assuming a relatively stable patient without indication for DCS or major co-morbidities, resection and primary anastomosis is a safe option for destructive colon injuries. This approach should be favored over fecal diversion due to lower rates of infectious complications. The anastomosis may be accomplished in either a hand-sewn or stapled manner. Proximal fecal diversion is not typically employed or necessary, and drains should be used selectively.

I. Fecal diversion remains a reasonable option for destructive wounds in the setting of on-going bleeding, significant co-morbidities, or prolonged "open abdomen" after initial DCS. Unfortunately, trauma ostomies are frequently not reversed, with studies indicating a 50% permanent diversion rate. When indicated, colostomy or ileostomy (for right-sided colon injuries) should be created through the rectus sheath. Eversion of the bowel wall in a Brooke manner aids with ostomy pouching and is encouraged, even for colostomies. In some instances, a loop colostomy may be useful (*e.g.*, sigmoid colon injury with concurrent complex open pelvic fracture), but most commonly end-stomas are created.

J. Early in the adoption of DCS, surgeons noted that leak rates from colonic anastomoses performed during the second-look operation far exceeded the rates of those created during single laparotomy. Similarly, failure to achieve fascial closure at the initial take-back and prolonged "open abdomen" are risk factors for both intra-abdominal abscess and anastomotic leak. Potential causes for these worse outcomes include generalized bowel wall edema, prolonged resuscitation requirements, and sepsis from fecal spillage or other infectious sources. Collectively, the data suggest that performing a colostomy is safer for patients in whom the abdominal fascia cannot be closed within 48 h of injury.

K. Under select circumstances, delayed primary anastomoses of the colon may be created following DCS. The patient should be fully resuscitated and other major intra-abdominal injuries definitively treated (*e.g.*, hepatic embolization, vascular repairs). Additionally, certain injury patterns may preclude safely re-establishing colon continuity. For instance, destructive colon wounds with concurrent traumatic pancreatic disruption should be treated with colostomy, regardless of other factors.

Rectal Trauma Refer to Algorithm in Fig. 51.3

A. Rectal trauma is almost always penetrating, with gunshot injuries comprising a majority of these injuries and stabbings a smaller portion. Blunt trauma is rarely a primary cause of rectal injuries given the rectum's anatomic location within the pelvis, though bony fractures in the pelvis can cause collateral injury to the rectum. The most common injury pattern associated with rectal injury is anteroposterior compression pelvic fracture which has been seen in up to 75% of patients with blunt rectal injury. Injuries can be classified as destructive vs. non-destructive or more categorically using the Organ Injury Scale (Table 51.1). Rectal injuries should also be described according to the location of the trauma in relation to the peritoneal reflection (intra- vs. extraperitoneal).

Performance of a digital rectal examination (DRE) alone is not a reliable indicator of rectal trauma. Recent trauma literature reported the clinical reliability and significance of DRE compared to other clinical indicators (OCI) as part of the primary and secondary survey. Abnormalities on DRE are half as likely to identify a rectal injury compared to OCIs. DRE does provide useful information regarding anal sphincter tone which may alter surgical plans. Overall, the recommendation is for combined CT and proctosigmoidoscopy in determining presence of a rectal injury.

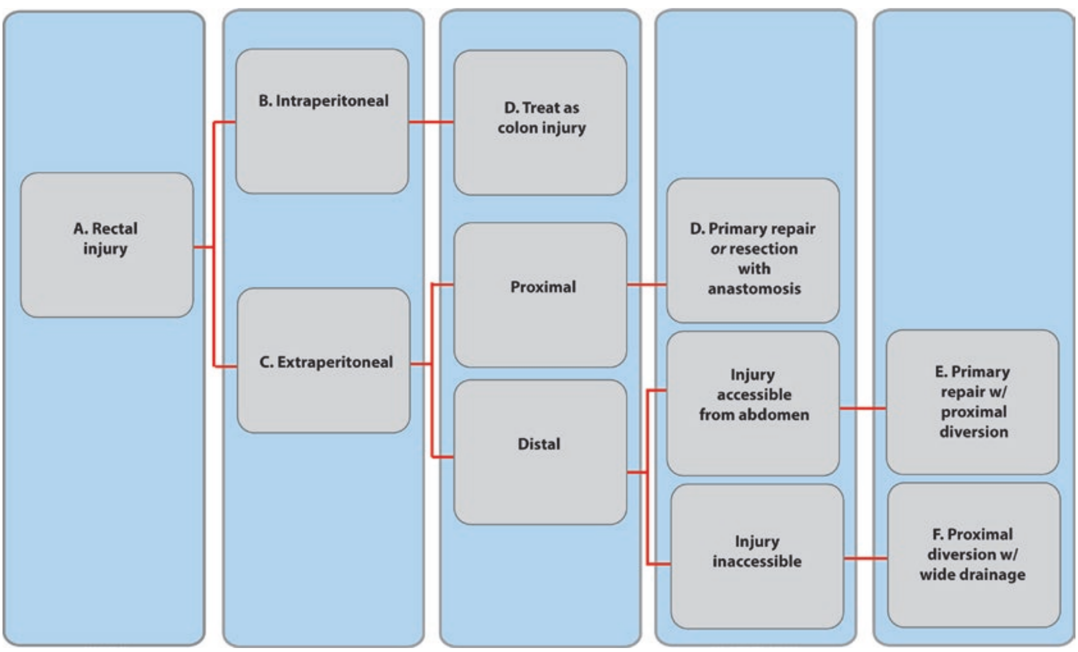

Fig. 51.3 Algorithm for managing rectal trauma

B. The proximal portion of the intraperitoneal rectum is anatomically identified by the splaying of the teniae coli. The distal extent is considered to be at the peritoneal reflection. The extraperitoneal portion is the distal remainder down to the anal canal. The rectal injury scale (Table 51.1) is largely similar to the colon injury scale.

C. Identifying and distinguishing rectal injuries often requires high clinical suspicion in the context of the mechanism of injury combined with diagnostic and physical examination. Intraperitoneal rectal injuries will often manifest similarly to colon injuries with the findings of free air, extraluminal air, unexplained intra-abdominal fluid, and oral or rectal contrast extravasation. Because of the extraperitoneal nature of the distal rectum, injuries are often difficult to identify and can be missed. Multi-detector computed tomography (CT) is useful in detecting penetrating injuries to the rectum, with the most sensitive finding being the presence of a trajectory to the bowel and the most specific being contrast extravasation or the identification of a clear mural defect in the wall of the rectum.

D. The surgical management of rectal injuries takes into consideration a few other factors besides the extra/intraperitoneal location of the injury, such as hemodynamic stability and concurrent injuries. In most instances, the best treatment is direct repair for rectal injuries involving <25% of the rectal circumference, or resection with primary anastomosis for more destructive injuries. These repairs have shown lower infection and wound complication rates compared to fecal diversion. Fecal diversion proximal to a repair may be considered, especially in patients with multiple co-morbidities that may impair anastomotic healing (*e.g.*, atherosclerosis, cirrhosis, malnutrition).

E. Distal rectal injuries that are accessible during laparotomy should be repaired primarily in conjunction with proximal fecal diversion, although there is some evidence to suggest that diversion is not mandatory in all patients. Recent EAST practice management guidelines conditionally recommend diversion while acknowledging the low quality of supporting data. Diversion is best accomplished with a loop stoma (colon or ileum). Every attempt at restoring rectal continuity should be made during the initial presentation, since re-operating for end-colostomy reversal several months after distal rectal trauma is quite difficult. However, prolonged efforts at repair of extraperitoneal injuries in unstable patients should be avoided.

F. Grossly devitalized ischiorectal and perineal tissue should be debrided. Distal rectal washout likely has no influence on outcome, although large fecal burden should be alleviated to avoid stercoral ulceration. Presacral drains are to be used judiciously. Such drains are only useful when they communicate with the rectal injury; healthy tissue planes should not be disturbed simply to place a presacral drain. Fecal diversion is best performed by loop sigmoid colostomy.

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52 Endometriosis

Bidhan Das and Michael J. Snyder

Refer to Algorithm in Fig. 52.1

A. As most women have endometriosis confined to the pelvis, the most common presentations of endometriosis are related to dysmenorrhea, pelvic pain, and infertility. Pain is the most common symptom of endometriosis, affecting 80% of patients who were subsequently diagnosed with the disease. Symptoms are related to the depth of penetration of the lesion, the type of lesion, and its location. Dyspareunia is usually a symptom of more advanced endometriosis and noted just prior to menstruation. This pain is correlated to fixation of the pelvic organs. Chronic noncyclic pelvic pain is associated with perineural inflammation and uterosacral ligament involvement with endometriosis. The cause of pain from endometriosis is unclear and may be related to the cyclic growth and increase in visceral pressure of the capsule surrounding the endometrial implant. Bowel involvement is associated with 12–37% cases of endometriosis, and the degree and symptomatology vary relative to the area affected. The rectosigmoid is involved in over 70% of patients, and this presentation can cause change in bowel habits, tenesmus, or even rectal bleeding. Colonic endometriosis, however, can present with obstructive symptoms and can be difficult to differentiate from other causes of large bowel obstruction.

B. The true prevalence of endometriosis is unknown. There is to date no noninvasive screening test, and retrospective population studies estimate 6.2% of premenopausal women have endometriosis. Additionally, that prevalence may be increased due to widespread use of exogenous estrogens and increasing obesity. The pathogenesis of endometriosis is very controversial, with beliefs that endometriosis is a result of transtubal regurgitation of menstrual blood, lymphatic spread, and hematogenous spread.

C. Physical examination may be normal, but a careful bimanual and rectal examination is a necessity and could reveal nodularity or induration in the uterosacral ligaments or the cul-de-sac of Douglas. Ovarian masses may be felt, and retroversion of the uterus may be noted as a sign of advanced disease.

D. Laboratory evaluation may demonstrate a modest rise in CA-125, but only in moderate to severe cases of endometriosis, thus the finding lacks both sensitivity and specificity.

E. Noninvasive testing is of little value in the diagnosis of endometriosis. Advanced disease can be seen on barium enema studies, which can reveal a narrow lumen (Fig. 52.2).

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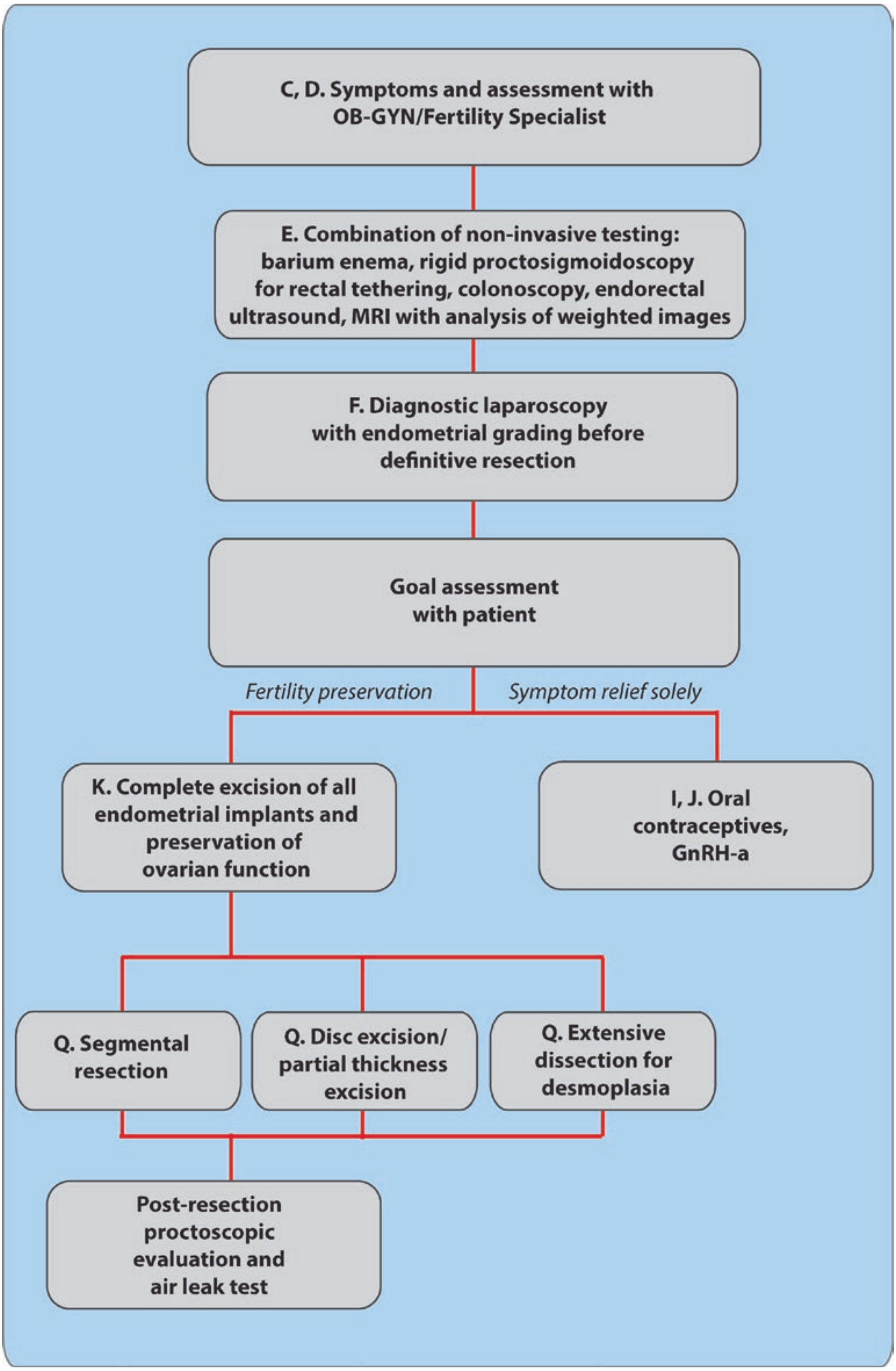

Fig. 52.1 Algorithm for endometriosis. *GnRH-A* gonadotropin-releasing hormone analogue

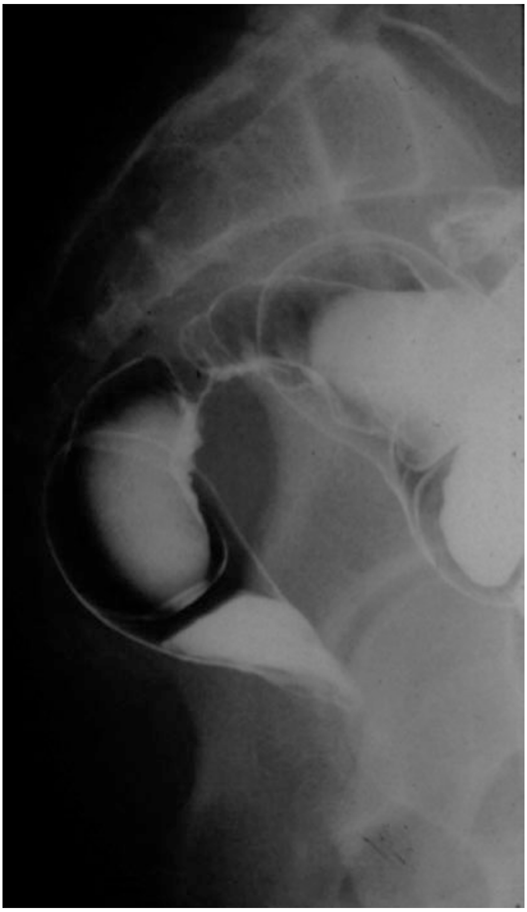

Fig. 52.2 Barium enema demonstrating narrowing of proximal rectum with cul-de-sac of Douglas endometrioma

Endoscopy may show stenosis, a mass, or polypoid lesion with advanced disease. Bluish submucosal discoloration can be seen as well. In our experience one example of locally invasive rectosigmoid disease is rectal tethering seen by an expert proctoscopist using an office rigid proctosigmoidoscopy. Endorectal ultrasound can be useful if physical examination is concerning for cul-de-sac involvement of the rectum. Endorectal ultrasound in limited studies has been shown to have a high specificity and high sensitivity for the need of intestinal resection in the setting of cul-de-sac involvement. In recent years MRI has been considered one of the best noninvasive modalities for imaging suspected endometriosis. Colorectal involvement is strongly suspected with a disappearance of the fat plane between the rectum and the vagina, loss of the hypointense signal of the anterior bowel wall on T2-weighted images, and a contrast enhanced mass on T1-weighted images involving the bowel wall. This modality depends on the hemorrhage that occurs in endometrial implants and has a sensitivity and specificity between 78% and 98%.

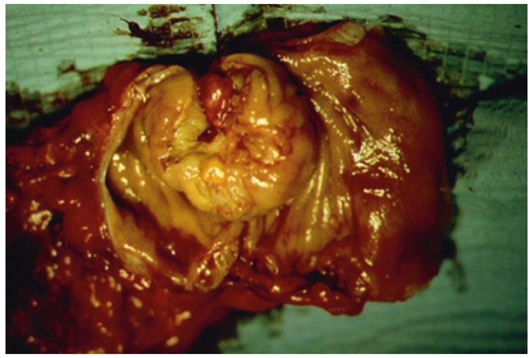

Fig. 52.3 Deep infiltration of an endometrial implant at the level of the rectosigmoid

F. Diagnosis of endometriosis usually requires direct visual inspection, and the gold standard of diagnosis is both visual and tactile evaluation of the abdomen and pelvis. Laparoscopy is often the initial approach to patients under suspicion of endometriosis and allows a detailed examination of the entire abdomen and pelvis with mobilization of both ovaries to evaluate the pelvic peritoneum with uterine manipulation to allow complete evaluation of the cul-de-sac of Douglas. The extent of endometriosis can be documented using a codified form to classify endometriosis. Classification systems currently do not assess the needs of the colorectal surgeon, however. There is no uniform type of endometrial lesion; lesions often change color or consistency over time; lesions in the cul-de-sac of Douglas often are desmoplastic, with depths of invasion that are often hard to assess laparoscopically (Fig. 52.3).
G. Many centers now report the use of robot-assisted laparoscopy as a technique to visual-

ize smaller lesions of the pelvis while also offering initial methods of treatment and a multimodal platform for both gynecologist and colorectal surgeon. We agree that this modality has promise; however, given the broad-ranging phenotypical presentation, we do not feel it has yet to replace open surgery in every presentation. The improved ergonomic dexterity of the robotic platform may well offer better diagnostic laparoscopy for the initial assessment of endometriosis, given the ability to have a stable view deep into the pelvis with a modicum of mobilization and a steady three-dimensional camera. Yet miliary pelvic disease may sometimes only be appreciable with tactile feedback, while lesions that are at the base of the appendix or on the distal ileum are often missed by all but the trained colorectal surgeon.

H. Treatment can be either medical or surgical or a combination thereof. However, medical therapy is purely for symptoms and largely for pelvic pain.

I. Oral contraceptives can be used to manage pelvic pain and dyspareunia by creating a pseudo-pregnancy with hyperhormonal amenorrhea to suppress the pituitary and ovaries, ultimately resulting in resorption of endometrial implants. Although limited in usage, this type of medical therapy offers advantages in that it avoids surgical intervention in a patient with contraindications (extensive adhesions, highly comorbid conditions).

J. GnRH-a is also a potent agent in the reduction of endometriosis symptoms. The synthetic hormone is administered in the mid-luteal phase of the menstrual cycle over a period of six months. Results are variable but impressive with complete response in symptoms in over 50% of women with laparoscopic follow-up demonstrating significant decrease in the size of the lesions in the majority of patients.

K. The major goal of surgery in endometriosis patients is complete excision of endometrial implants while preserving ovarian function. Additionally, many techniques have been employed to reduce adhesion formation, including postoperative steroid therapy, lavage with collagenase gels, and transient laparoscopic placement of temporary spacers in the pelvis. In most major centers of surgical treatment of endometriosis, these patients are approached in concert with gynecologists to completely remove all gross disease. Exploratory laparotomy is the gold standard to diagnose and to classify endometriosis, and it allows complete evaluation with tactile feedback for complete extirpation.

L. Many gynecologists utilize vaporization via electrocautery or CO_2 laser, to remove endometrial implants, but both modalities are notable for delayed iatrogenic injury.

M. We recommend full mechanical and antibiotic bowel preparation as well as prophylactic antibiotics with positioning in the low-lithotomy position for access to both vagina and rectum for instrumentation. We liberally utilize ureteral stents to facilitate dissection of the ureters as well as dissection of lesions from the ureters.

N. A decision for colonic resection is undertaken with three major indications: (a) full thickness deficit from lesion excision that would ultimately require repair that is too extensive to be sutured (b) lesions that impact the function of the bowel

(c) mesenteric dissection that could create ischemia. Surgical techniques for resection during endometriosis are not standardized, so comparison of literature cannot be performed. Additionally, as popularity of the robotic platform has grown, there are centers that design a multidisciplinary approach completely around a robot-assisted laparoscopic approach.

O. Small bowel and appendiceal endometriosis is uncommon and often hard to correlate symptomatically. Recurrent pain, bloating, and occasional change in bowel habits are all thought to accompany such a presentation. Appendiceal implantation is treated with appendectomy, while small bowel endometriosis treatment is determinant upon the size and location of the lesion. Smaller lesions may be amenable to wedge/disc excision and

suture primary closure. However, if the lesion is adjacent to the ileocecal valve or particularly large, a segmental bowel resection or ileocecectomy may be warranted.

P. Rectosigmoid endometriosis can be readily treated by sigmoid colectomy with margins being grossly normal. A “segmental” operation is appropriate for this benign disease, and thus high ligation of the IMA pedicle is not warranted. Randomized data demonstrate a superior pain and postoperative complication profile in a group of laparoscopically performed colectomies when compared to open techniques. Additionally, the laparoscopic approach offered a higher spontaneous pregnancy rate.

Q. Endometrial disease in the cul-de-sac of Douglass that extends into the rectovaginal septum is the most common site of intestinal endometriosis and may require intestinal resection. These diseased areas carry a strong desmoplastic reaction, are often very deep and fibrotic, and extend from the posterior vagina to the uterosacral ligaments. There is substantial distortion of the normal tissue planes, requiring a more seasoned colorectal surgeon. Pararectal spaces posteriorly and laterally are dissected with circumferential dissection around the nodule. Ureters are dissected appropriately, and the lesion can be removed first from the rectum and then dissected from the vaginal fornix. It is worthwhile to note that one must be careful to avoid injuring the cervix in order to best preserve fertility. Rectal lesions that are removed with rectal preservation (partial-thickness) should be evaluated with a proctoscopic evaluation for air-leak and are often reinforced with imbricating Lembert suturing. Deeper lesions require careful and expert colorectal evaluation. There are effectively two options in these situations, full-thickness disc excision and segmental resection. We often perform full-thickness disc excision for single lesions less than 3 cm in diameter. However, it is worth noting that the margins should be very clearly normal, particularly given data that demonstrated 40% of full-thickness disc excisions of bowel implants were incomplete. We often delineate the disc-like area with electrocautery with stay sutures on either side of the implant. Full-thickness excision is undertaken with cutting current, while interrupted transverse sutures are placed to close the defect.

R. Our experience with surgical therapy is very promising, with 86% of patients having complete or near-complete relief of their preoperative pelvic pain. A 50% crude pregnancy rate was achieved which was comparable with milder disease, all achieved without any anastomotic leaks and no documentation of recurrent colorectal endometriosis.

S. A combination approach that utilizes preoperative medical therapy for 3–6 months may well be warranted to decrease inflammation and possibly size of endometrial implants as well as vascularity. Our current use of combined therapy is a 3–6 month course of GnRH-a prior to definitive resection of all endometrial disease.

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Colonic Conditions: Ulcerative Colitis

53

Megan C. Turner and John Migaly

Refer to Algorithm in Fig. 53.1

A. Introduction to UC:

Ulcerative colitis (UC) is an inflammatory bowel condition of unknown etiology affecting the mucosa of contiguous segments of colon and rectum. It manifests as relapsing abdominal pain, fever, diarrhea, blood per rectum, and weight loss. The daily management of UC is medical in nature, however 40% of UC patients will ultimately require an operative intervention. The surgeon's role in emergent, and elective resection, for UC and its oncologic sequelae cannot be understated (Fig. 53.2).

B. Epidemiology: Ulcerative Colitis is predominantly diagnosed in early adulthood following evaluation for abdominal pain, weight loss, fevers, and bloody diarrhea. There is no gender discrepancy. Race differences are present, with those of Jewish heritage most frequent affected, followed by Caucasians, and African Americans. Lower prevalence is seen amongst Hispanic, Native American, African, and Asian populations. Globally, the incidence is variable, but as common as 15/100,000 in industrialized nations. Increasing prevalence in recently industrialized regions supports environmental influence on the development of the disease. Genetic and autoimmune associations are being explored as well.

C. Clinical Presentation: Presentation can vary widely, from emergent pan-colonic flare with hypotension and tachycardia, to indolent symptoms of persistent abdominal pain. Proctosigmoiditis is the most common presentation, and pan-colitis is the second most common, with the two accounting for greater than half of all presentations. Symptoms correlate with disease severity. Remission is characterized by the improvement of symptoms, and are associated with the resolution of mucosal inflammation on endoscopic exam.

D. Radiologic Evidence: Radiographic imaging is utilized for diagnosis of complications of UC. Abdominal radiographs assist in diagnosis of obstruction and perforation, followed by computed tomography (CT) in the hemodynamically normal patient. Double contrasted CT with barium enema is used to detect longstanding colonic changes such as absence of haustra, narrowing of the lumen, and ulceration. However, these features are better visualized on endoscopy. Additionally, CT plays a role in

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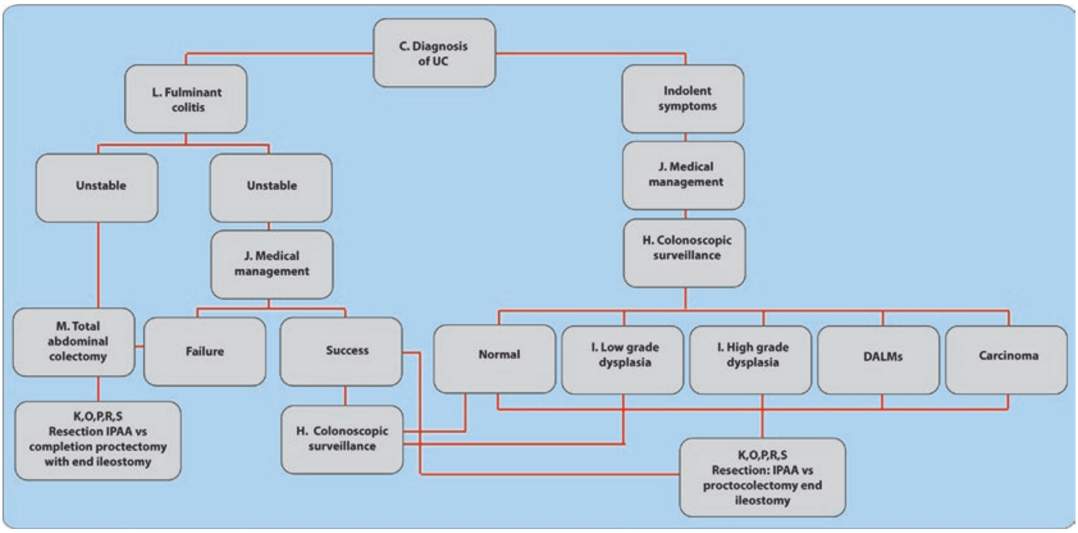
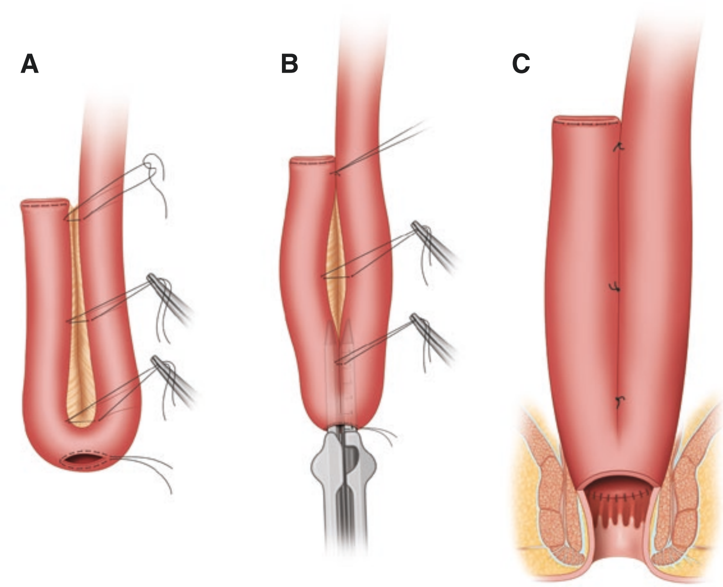


Fig. 53.1 Algorithm for the operative management of ulcerative colitis. *UC* ulcerative colitis, *IPAA* ileal pouch-anal anastomosis, *DALM* dysplasia-associated lesion or mass. Superscript indicates corresponding chapter segment

Fig. 53.2 J Pouch formation and pouch-anal stapled anastomosis



the diagnosis of postoperative complications following resection such as anastomotic leak or abscess formation. A gastrograffin enema is appropriate to rule out complications such as anastomotic leak, fistula formation, and stricture prior to diverting loop ileostomy take down.

E. Diagnostic Labs: Infectious colitides caused by Cytomegalovirus, *Clostridium difficile*, *Escherichia coli, Salmonella*, *Shigella*, *Campylobacter*, and *Entamoeba* species have presentations similar to UC, and should be ruled out prior to invasive diagnostics. A comprehensive metabolic panel,

nutrition laboratories, and a complete blood count can provide insight into the overall debility of severely affected patients.

F. Endoscopy for Diagnostics: Endoscopy with biopsy is the cornerstone of diagnostics for UC. Direct visualization of the mucosa plays an important role in differentiating UC from Crohn's Disease and infectious colitides. Visualization of the mucosa shows ulceration and inflammatory changes with neovascularization present both contiguous and confluent, beginning in the rectum and progressing proximally. Full colonoscopy allows for assessment of proximal extent of colitis and presence of backwash ileitis in patients who have involvement at the cecum. Histologic evaluation shows inflammatory changes, goblet cell depletion, and vascular congestion. Ulceration of the mucosa and infiltration of inflammatory cells precedes crypt abscess formation and rupture. Persistent untreated disease ultimately leads to atrophy of the mucosa.

G. Extracolonic Manifestations: Ulcerative Colitis has a 20% incidence of extracolonic disease. The most common manifestations are musculoskeletal arthropathies, both axial and peripheral, followed by ophthalmologic, dermatologic, thromboembolic, and hepatobiliary. Following definitive proctocolectomy, peripheral mono-arthropathies, erythema nodosum, and iritis resolve. However, ankylosing spondylitis, primary sclerosing cholangitis (PSC), uveitis, and episcleritis persist, independent of colonic disease. Additionally, the presence of PSC dramatically increases the risk of colonic malignancy, independent of colonic inflammation. PSC may become severe enough to require liver transplantation, and carries substantial risk for cholangiocarcinoma.

H. Surveillance: Surveillance for dysplasia becomes increasingly important for patients with long-standing disease. It is postulated that carcinoma develops from dysplastic lesions in the affected hyper-inflammatory segments of the colon and rectum. Absolute risk of colorectal cancer rises to 10% for patients whom have had active disease for 20 years. Given this high risk, surveillance guidelines are well established, but the indications and timing of proctocolectomy continue to be debated. Colonoscopic surveillance should occur every 1–3 years, beginning ten years from diagnosis. Colonoscopy should include deliberate inspection of the mucosa as well as random biopsies for surveillance of dysplasia every 10 cm along the length of the colon through the ileocecal valve as has been historically recommended is under debate. With newer endoscopic technologies "invisible dysplasia" likely accounts for less than 10% of patients diagnosed with dysplasia. Identification of carcinoma requires not only resection of the focal lesion, but total proctocolectomy.

I. Management of dysplasia: When dysplasia is identified from surveillance biopsies, the specimens should be reviewed by independent pathologists to confirm congruent assessment of the nature of the lesions. The presence of dysplasia is a herald of disease progression along the inflammation-dysplasia-carcinoma pathway, and overall represents a field defect for the entirety of the colon and rectum. Synchronous tumors are more common in UC related than in sporadic malignancy. This necessitates discussion with the patient of the value of continued colonoscopic surveillance versus resection. Current recommendations are to proceed with repeat colonoscopy if the lesion was endoscopically resectable and discuss proctocolectomy for lesions that are incompletely resectable. As lesions are generally endoscopically visible, descriptions using the Paris classification and Surveillance for Colorectal Endoscopic Detection and Management in Inflammatory Bowel Disease International Consensus Recommendation (SCENIC) descriptors should utilized to describe them. Prior categorizations as dysplasia-associated lesion or mass (DALMs), have been abandoned.

(a) Descriptions of visualized lesions should include whether the lesion is

within or outside the area of known colitis. The morphology, borders, and features of submucosal invasion should be included. Additional features have been described (Table 53.1).

(b) High-grade dysplasia: These lesions are then categorized as endoscopically resectable, or unresectable. i. Resectable lesions include those with distinct margins, execution of complete removal with endoscopy, and histologic examination is consistent with complete removal. ii. Unresectable lesions include those without distinct margins and incomplete removal on endoscopy either grossly or by histopathology. iii. Kudo pit classification is not widely accepted for lesion characterization. However, Kudo pit classification I and II may have utility in ruling out dysplastic changes.

(c) DALMs.

J. Medical Management: Steroids, aminosalicylates, and immunomodulators are used in medical management for patients with UC via mechanisms that decrease inflammation and promote mucosal healing. Isolated proctitis is best managed with topical therapies including mesalamine suppositories, and steroid enemas. Oral aminosalicylates are used for maintenance therapy in proximal colitis. Oral steroids and immunomodulators are added in a stepwise fashion for increasing disease severity. Resolution of symptoms indicates remission, and should be confirmed with mucosal visualization on endoscopy. Histologic examination reveals absence of neutrophils in the epithelial crypts indicating complete remission. With severe symptom flares, admission to the hospital, bowel rest, and intravenous steroids are standard of care. While intravenous antibiotics are routinely used, there is not a definitive outcome benefit based on the current literature. Infliximab and cyclosporine have shown short-term benefit in small trials, but the long-term impact on overall disease progression has not been determined. Infliximab and cyclosporine should not be used in combination as they substantially increase the risk of infectious complications should urgent operation be required. The majority of patients will respond to medical therapy and will not require operative intervention during hospitalization. For those who are medically managed to discharge, discussions regarding potential future operative interventions should be

Table 53.1 Terminology for reporting finding on colonoscopic surveillance of patients with inflammatory bowel disease

Term	Definition
Visible dysplasia	Dysplasia identified on targeted biopsies from a lesion visualized at colonoscopy
Polypoid	Lesion protruding from the mucosa into the lumen ≥2.5 mm
• Pedunculated	Lesion attached to the mucosa by a stalk
• Sessile	Lesion not attached to the mucosa by a stalk (entire base is contiguous with the mucosa)
Nonpolypoid	Lesion with little (<2.5 mm) or no protrusion above the mucosa
• Superficial elevated	Lesion with protrusion but <2.5 mm above the lumen (less than the height of the closed cup of a biopsy forceps)
• Flat	Lesion without protrusion above mucosa
• Depressed	Lesion with at least a portion depressed below the level of the mucosa
General descriptors	
• Ulcerated	Ulceration (fibrinous-appearing base with depth) within the lesion
• Border	
– Distinct border	Lesion's border is discrete and can be distinguished from surrounding mucosa
– Indistinct border	Lesion's border is not discrete and cannot be distinguished from surrounding mucosa
Invisible dysplasia	Dysplasia identified on random (non-targeted) biopsies of colon mucosa without a visible lesion

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held. Specifically, indications for resection, timing of withholding steroids and immunologics prior to resection. In our practice, steroids are tapered to off if symptoms permit. However, immunologics are discontinued for several weeks prior to surgery (infliximab: 8 weeks, adalimumab: 4 weeks). Aminosalicylates are continued up to the date of surgery.

K. Surgical Indications: Hemorrhage, perforation, toxic colitis refractory to medical intervention are indications for urgent/emergent resection. Elective resection is indicated for patients with refractory symptoms, extracolonic manifestations, growth retardation, dysplasia, and carcinoma.

L. Emergent Operations: While emergent presentations of UC flares are increasingly managed with advanced medical therapies as described above, there remain a subset of patients who require urgent operative intervention. Candidates include those with toxic megacolon, fulminant colitis, hemorrhage, and perforation. In most urgent settings an open approach total abdominal colectomy with end ileostomy is appropriate as described below.

M. Total Abdominal Colectomy (TAC): Total abdominal colectomy with end ileostomy addresses the systemic impact of inflammatory colitis, diverts the fecal stream, allows for improvement of the patient's hemodynamics, nutrition parameters, as well as the tapering off of steroids, and the holding of immunologic medications in preparation for definitive resection, and restoration of continence. The rectum is preserved in these operations to maintain dissection planes for future operations. Management of the rectum may be stump closure and observation, exteriorization with a mucus fistula, or placement of a rectal tube.

N. Postoperative Care Following TAC: Observation, stabilization, and frequent abdominal assessment are cornerstones of management following TAC. Rectal stump management has historically used the formation of a mucous fistula to prevent subsequent pelvic sepsis. More recent literature suggests that overall rates of pelvic sepsis are approximately 10% with an intraperitoneal, or intrapelvic, closed stump. These rates are similar to previously reported rates of pelvic sepsis with a mucous fistula, 7%, leading many surgeons to close rectal stumps instead of forming mucous fistulas. Following TAC for UC, approximately 50% of patients ultimately undergo rectal resection. Half of these resections are for refractory proctitis, and half for dysplastic changes or carcinoma of the residual rectum.

O. Elective Operations: The elective operation of choice is a total proctocolectomy with ileal pouch-anal anastomosis (IPAA) as it removes all foci of disease allowing for resolution of symptoms, management of oncologic risk, and mitigation of extracolonic disease. Alternatives include total proctocolectomy with end ileostomy, and total abdominal colectomy with ileorectal anastomosis, all of which can be performed using minimally invasive techniques by experienced surgeons. Candidates for resection are patients who have symptoms refractory to medical management, those with dysplasia or progression to carcinoma, and those with extracolonic manifestations that are improved with colonic resection. Failure to thrive and growth retardation are indications in the pediatric population.

Regardless of technique, bowel preparation with mechanical and enteral antibiotics are administered preoperatively, IV antibiotics are administered one hour prior to incision, and the patient is given prophylactic heparin to mitigate postoperative complications.

P. Laparoscopic Technique for IPAA: The laparoscopic technique utilizes positioning in modified lithotomy with access to the anus, and preparation amenable to open conversion. Lighted ureteral stents may be useful in obese patients, patients with prior abdominal operations, or simply aid in the

efficient location of ureters to expedite what can be a lengthy case. A four working-port technique is utilized; a 12 mm port in the right iliac fossa, usually the site of the future ileostomy, and 5 mm ports in the left upper quadrant, the right upper quadrant, and the left iliac fossa. The camera port is usually in the supraumbilical position. The dissection is started with identification of the right and left ureter by way of the lighted stents, or by beginning the mobilization underneath the Inferior Mesenteric Artery (IMA). The sigmoid colon is placed on tension and the root of the mesentery is scored to the root of the IMA. The dissection is performed medial to lateral, skeletonizing the IMA, identifying the left ureter, and taking both the IMA and inferior mesenteric vein (IMV) with a vascular stapler. The left and sigmoid colon are mobilized, followed by freeing the transverse colon of the omentum, then mobilizing the splenic flexure. The right colon is approached placing the cecum on tension and initially identifying and preserving the ileocolic and the ileal vessels which will ultimately supply the pouch. Dissection is in the avascular plane beneath the right colon and anterior to the retroperitoneum with attention to identifying the right ureter and gonadal vessels. Approaching cephalad, the duodenum is identified and avoided. The ileocolic pedicle taken with electrocautery with high ligation. Once this is complete, the right colon is mobilized in a medial to lateral fashion. When the right colon is free it is repositioned medially and the white line of Toldt is approached up to the hepatic flexure. The location of the duodenum is confirmed, and moved out of the dissection field. The root of the small bowel mesentery is mobilized to the origin of the Superior Mesenteric Artery (SMA) at the third portion of the duodenum for optimal length to maximize the tension free reach of the pouch into the pelvis. The colon is then devascularized using an energy source along the transverse mesocolon. At this point in the operation, the colon is fully mobile from the cecum to the rectosigmoid junction. Attention is turned to the rectum, locating the plane between the presacral fascia and the fascia propria of the rectum. The circumferential rectal dissection is performed down to the levators, clearing the mesorectal attachments while avoiding the left and right hypogastric nerves. In female patients, the anterior dissection must remain clear of the vagina. This can be facilitated by utilization of a retractor placed within the vagina. There are limitations to dividing the rectum at a 90° angle along its long axis using an endoscopic stapler. In our practice we use an Endo-GIA stapler with a purple load to divide the rectum flush with the levators. This is facilitated by the assistant retracting the rectum to the left, and approaching from the right iliac fossa port using sequential fires of the stapler to transect the rectum. The colon is then exteriorized through the umbilical port site which is enlarged to accommodate the specimen. Alternatively, the colon can be exteriorized through the ileostomy aperture. However, utilizing the umbilical camera port site allows for easier orientation of the mesentery and creation of the pouch. The ileum is divided flush with the ileocecal valve, and the colonic specimen is removed from the field and sent to pathology. If there are remaining concerns for Crohn's Disease, an examination by the pathologist can be helpful for operative planning at this time. Importantly, three-stage procedure should be considered to allow a more accurate diagnostic determination via permanent pathology. The terminal ileum is exteriorized at this time, and a 15–18 cm J-pouch is created by folding the distal ileum on itself. To confirm adequate length, the tip of the pouch should reach past the symphysis pubis. The J-pouch is fashioned with GIA 80 staplers in sequential fires. A 2-0 prolene purse-string suture is placed and a 28-EEA anvil is secured at the bottom of the J. The pouch/anvil combination is replaced into the abdomen, and

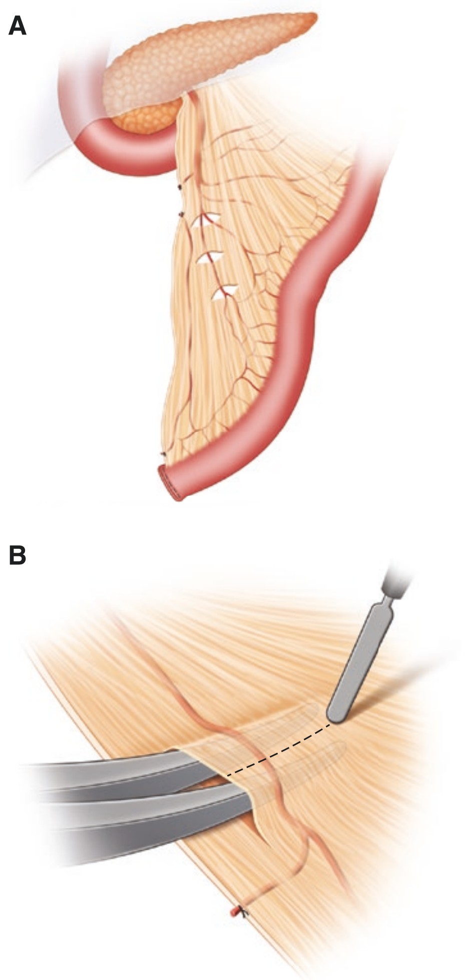

Fig. 53.3 Mesenteric rents to increase length for tension-free anastomosis

insufflation is resumed. The J-pouch is placed within the pelvis with careful attention to avoidance of rotation, and assess for easy reach without tension. The assistant moves to the foot of the table, and transanally passes the stapler immediately adjacent to the rectal transection staple line. The stapler and anvil are engaged with the surgeon grasping the anvil to prevent rotation while the stapler is closed. The vagina is retracted out of the reach of the stapler to ensure it is not inadvertently incorporated into the staple line (Fig. 53.3). When complete, the stapler is removed and two anastomotic donuts can be visualized. The pelvis is filled with irrigant at this time, and rigid proctoscopy with inflation is performed to confirm an airtight anastomosis and pouch. The irrigant is evacuated and the pouch is observed to lie in anatomic position. Our practice is to routinely create a diverting ileostomy, but not leave pelvic drains. A diverting loop ileostomy is then formed 30 cm proximal to the J-pouch in a standard Brooke fashion.

Q. Troubleshooting IPAAs: Several techniques can be used to obtain additional bowel length when the pouch does not reach without tension into the pelvis. First, and likely most important, it is appropriate to convert to an open procedure at this time to safely facilitate additional length into the pelvis. One technique is to make sequential rents in the small bowel mesentery (Fig. 53.3). Additionally, selective ligation of branching vessels along the mesentery can provide additional reach. Our approach is to use bulldog vessel clamps on the vessels and observe for appropriate perfusion along the bowel prior to sacrifice of the vessel. Finally, the configuration of the pouch into a 'S' or 'W' configuration can provide additional length. Some surgeons elect to remove the colonic specimen and exteriorize the ileum through the future ileostomy site. However, this creates difficulty in judging the orientation of the mesentery, allowing it to rotate when replaced into the abdomen. This can be avoided by exteriorizing through the umbilical site as described above, where the free edge can be visualized down to the level of the origin of the vessels.

R. Open Technique IPAA: The patient is placed in modified lithotomy with adequate access to the anus, and the abdomen is prepped widely. The abdomen is entered at the midline. The right colon is mobilized in a lateral to medial direction with the lateral peritoneal reflection incised from the cecum

to the hepatic flexure. The right ureter and duodenum are carefully identified and protected during mobilization. The transverse colon is sharply divided from the greater omentum. The splenic flexure is then mobilized, and the left colon is reflected medially with identification and protection of the left ureter. The vascular supply of the terminal ileum via the ileocolic and ileal branches are identified and preserved, and the terminal ileum transected with a linear stapler. The mesentery is then divided. Attention is turned to the rectum which is then elevated out of the pelvis. Circumferential dissection is achieved to the level of the levators, identifying and protecting the hypogastric nerves. The rectum is divided and the entirety of the colon is passed off to pathology as a specimen. The terminal ileum is folded onto itself in formation of the J pouch. The pouch is placed into the pelvis without tension or rotation. The apex of the J is then brought through the muscular cuff and sutured to the anus at the dentate line. A diverting loop ileostomy is created, the abdominal wall is closed, and the diverting loop ileostomy is matured in a Brooke fashion.

S. Total Proctocolectomy with End Ileostomy: Standard of care for surgical management of UC traditionally has been total proctocolectomy with end ileostomy. While largely replaced by IPAA as described above, it remains an appropriate operation for those with poor sphincter function.

The patient is placed supine in lithotomy position. The anus is sutured closed at the start of the operation, and the abdomen and anus are widely prepped. Entrance into the abdomen is made through a vertical midline incision, and attention is turned to the right colon where a lateral to medial approach is taken from the cecum to the hepatic flexure. Care must be taken to identify and protect the right ureter and the duodenum. The transverse colon is mobilized by sharp dissection of the omentum away from the colon. The splenic flexure and the left colon are approached laterally to medially, reflecting the colon medially. Care must be taken to identify and protect the left ureter. When the colon is fully mobilized, attention is turned to the terminal ileum which is transected with a linear stapler. The peritoneum is scored along the mesentery, then divided. Attention is turned to the pelvis, and the rectum is elevated for ease of circumferential dissection to the levators, while protecting the hypogastric nerves. The assistant goes to the bottom of the table and incises the skin around the anus. The levators are incised anteriorly, and the specimen is released and passed off to pathology. Drains are placed in the pelvis. The terminal ileum is brought through the abdominal wall, the abdomen and perineum are closed, and the end ileostomy is matured in a Brooke fashion.

T. Turnbull Blowhole: The Turnbull 'Blowhole' procedure is utilized in decompensated UC patients. It is largely of historic significance, and used in septic, steroid dependent, malnourished patients who cannot withstand a more extensive resection, though this is rare in modern surgical and anesthetic care. The operation consists of loop ileostomy and a transverse colostomy, with or without a sigmoid colostomy for rectal decompression. Diversion of the fecal stream and decompression of the colon allows for medical stabilization and nutritional optimization of the patient prior to total abdominal colectomy. However, with the colon remaining in-situ this approach does not address the systemic inflammatory impact of the colitis, thus impairing rate of recovery.

U. Continent Reconstruction: The decision for a three stage, two stage, or single stage procedure is based on the physical robustness of patient. With rates of pelvic sepsis following proctectomy with IPAA in the range of 10%, most surgeons advocate for the use of fecal stream diversion. In a recent study, the lack of diversion was associated with a nearly five-fold risk of pelvic sepsis. The most met-

abolically deranged patients, those who are on high doses of steroids, or immunomodulators, those who have poor nutrition, and those present with sepsis whom are resected urgently are most appropriate for a three stage procedure: total abdominal colectomy with end ileostomy, IPAA with diverting loop ileostomy, and loop ileostomy take down. The interim allows for tapering of steroids, holding of immunomodulators, and improvement of nutritional parameters to mitigate risk of anastomotic and wound breakdown. Elective resections are performed in a two-stage procedure: IPAA with diverting loop ileostomy, and subsequent ileostomy take down. This is the practice at our institution, allotting for protection of the ileoanal anastomosis in the immediate recovery period. A single stage procedure, IPAA without diversion, is not currently practiced at our institution given the risk of pelvic sepsis and its long-term sequelae. Patients who potentially could be considered for a single stage operation include those who are young, fit, nutritionally replete, not taking steroids or immunomodulators.

V. Impact of Infliximab on Surgical Outcomes: Infliximab is increasingly used for medical management of UC, and the impact on postoperative complications is the subject of debate. The best literature to date suggests that there is an increased risk of postoperative complications for patients who have used infliximab for medical management of their disease preoperatively. There is an increased risk for a three-stage procedure. However, the data evaluated to generate these conclusions is heterogeneous, and it has yet to be determined the effect of infliximab versus whether it is a surrogate for more aggressive disease. While the half-life of TNFa inhibition is understood, the duration of biologic activity is less clear, making recommendations regarding timing of surgery relative to last dose a challenge.

W. Complications: Complications following pouch surgery can be categorized as perioperative and long-term. Perioperative complications following IPAA include incontinence, early small bowel obstruction and pelvic sepsis. Long-term complications include small bowel obstruction, anastomotic stricture, fistula formation, sexual complications, and pouchitis.

(a) Pelvic Sepsis: Pelvic sepsis occurs at a rate of 5% following IPAA in the setting of anastomotic leak, dehiscence, or infection of postoperative hematoma. Fever, tachycardia pelvic pain, and decreased pouch function are indicative of sepsis, and the diagnosis is confirmed with CT imaging. Management can be with percutaneous drainage, or with exploration, washout, revision of the anastomosis with proximal diversion or end ileostomy. The sequelae of pelvic sepsis predisposes the patient to fistula formation and can impact function of the pouch secondary to fibrosis. Complications of higher severity may require revision IPAA.

(b) Incontinence: Nearly half of patients undergoing IPAA will experience initial nocturnal low volume incontinence of stool, with rates of approximately 20% at 1 year. The majority of patients with nocturnal soilage show improvement over time.

(c) Small Bowel Obstruction: Early small bowel obstruction is uncommon, but may require early operative re-intervention. Conversely, adhesive small bowel obstruction occurs in 30% of patients who are followed for 10 years postoperatively. Non-operative management is successful in 90% of these occurrences, but hospitalization and decompression represents significant distress to the patient.

(d) Stricture: Anastomotic strictures occur at a rate of 5–30% and can be the result of technical error leading to narrowing of the lumen, tension on the anastomosis, infection, or ischemia. Management is serial dilations under anesthesia. Reoperation is rarely indicated.

Evaluation for stricture with gastrograffin enema is prudent prior to take down of diverting ileostomy.

(e) Fistula Formation: Pouch-vaginal fistulas occur at a rate of 3–15%. Increased vaginal discharge is the typical presenting symptom, or fistulae may be found during evaluation for ileostomy take down. Stepwise management can be with seton placement, endoanal ileal advancement flap, gracilis muscle interposition, or require pouch revision, depending on severity and previous failed closure attempts. Proximal diversion alone is typically insufficient for closure of the fistula tract. Evaluation for fistula with gastrograffin enema is prudent prior to diverting ileostomy take down.

(f) Sexual Complications: Women with UC of childbearing age who undergo proctocolectomy have decreased fertility compared to women who elect for medical management. This is postulated to be the result of pelvic adhesive disease obstructing the fallopian tubes. Mitigation of this risk includes medical management of UC, TAC with ileorectal anastomosis, or TAC with end ileostomy, with plan for subsequent IPAA when childbearing is complete. There is no impact on male fertility. Men with UC report improved sexual quality of life following IPAA. While data regarding rates of erectile dysfunction and retrograde ejaculation are mixed, overall sexual satisfaction compared to preoperative function is preserved to improved. Women report increase in dyspareunia, but overall unchanged coital or orgasm frequency following IPAA.

(g) Pouchitis: Pouchitis, presenting as increased stool frequency, bleeding, abdominal pain, incontinence and fever, approaches a 50% occurrence rate 10 years postoperatively from IPAA. It occurs as a result of bacterial overgrowth, and is treated with aerobic and anaerobic antibiotic coverage. Refractory symptoms may be alleviated with topical steroids or aminosalicylates. Furthermore, chronic or cyclic antibiotics may also be required. Chronic pouchitis requires re-evaluation for Crohn's disease. Proximal diversion typically does not resolve symptoms, and excision and creation of a new pouch will likely result in recurrent symptoms of the new pouch. Pouch excision and end-ileostomy are rarely required. Finally, it is important to ensure that pouchitis is not a manifestation of "cuffitis" where there is residual tissue between the dentate line and pouch anastomosis that is chronically inflamed. While this may respond to topical therapy, mucosal stripping may be required.

(h) Re-do IPAA: Pouch failure requiring excision and end ileostomy versus re-do occurs between 3–15% of patients, with sepsis being the driving cause. Re-do IPAAs can be performed transanally or transabdominally and are associated with similar quality of life relative to primary IPAA. Re-do surgery is associated with increased risk to nerve, ureter, and vessel injury.

X. Functional Outcomes: Following IPAA and diversion take down, patients typically experience six bowel movements in a 24 h period. The long-term patient satisfaction with symptom improvement is remarkable, with high quality of life scores that persist over time.

Y. Stoma Complications: While most stomas are tolerated well, several complications can occur, and up to 30% of patients with end ileostomy will require re-intervention on their ostomy. These complications include retraction, stenosis, prolapse, and parastomal hernia. Skin excoriation is common and can be mitigated with appropriately sized appliances.

Z. Continent Ileostomy: The continent ileostomy, Kock pouch, is largely of historical significance secondary to its high rate of complications and the improved techniques for sphincter preserving operations. Candidates are highly motivated patients

who are unable to undergo IPAA/IRA. Following total abdominal colectomy an ileal pouch is created with 45 cm of small bowel folded into an 'S' formation. The distal outflow is configured into intussusception which serves as an in situ valve. As stool builds in the pouch, the pressure occludes the valve preventing evacuation. The pouch is initially cannulated to gravity drainage, and is matured overtime with increasing volumes of distention for extended periods of catheter clamp time. Ultimately, the goal is to cannulate the pouch for evacuation several times per day. Postoperative complications are common: in addition to complications seen with loop and end ileostomy, herniation, stricture, prolapse, and excoriation, the Kock pouch can be complicated by fistula formation, subluxation of the nipple valve, and perforation with cannulation. These complications carry significant morbidity and risk of sepsis, and ultimately many are converted to traditional end ileostomy.

AA. Ileorectal Anastomosis: Ileorectal anastomosis (IRA), while having the benefit of preserving the reservoir function of the rectum, is infrequently performed in the setting of UC. This is secondary to continued inflammatory symptoms of the rectum, and the annual rectal mucosal surveillance required. For elderly patients, those who have a limited life span, and who have minimal symptoms at the rectum, without evidence of dysplastic changes, an IRA may be appropriate. If refractory symptoms occur, or neoplasia is identified in the rectum, these patients are candidates for IPAA or completion proctectomy with end ileostomy. Strict surveillance for dysplasia of the rectal tissue is required. Additionally, chronic medical management strategies must be employed to mitigate proctitis symptoms.

BB. Indeterminate Colitis: Approximately 10% of patients affected with colitis will not fit diagnostic criteria for either Crohn's disease or ulcerative colitis. Previously, this entity was referred to indeterminate colitis (IC) which is now a designation reserved following confirmation with specimen pathology, and the term inflammatory bowel disease unspecified (IBDU) is the preferred preoperative distinction. In this scenario, the most appropriate surgical management can be difficult to discern, especially in the setting of fulminant colitis. Recent studies demonstrate equivalent outcomes between patients with UC, IC and IBDU following IPAA.

CC. Postoperative Care: Historically, postoperative management for colonic resection included nil per os until return of bowel function, and serial monitoring of postoperative laboratories. In the modern era, enhanced recovery protocols (ERAS) are found to be safe, effective, and practical. At our institution, for appropriately selected patients, we use the following ERAS protocol. Preoperatively, patients undergo a mechanical and non-absorbable enteral antibiotic preparation. An epidural pain catheter is placed preoperatively, and managed by our anesthesia colleagues both intra- and postoperatively. Intraoperative goal directed fluid resuscitation is used following hemodynamic and urine output metrics. A regular diet is resumed on postoperative day zero. Postoperative day one, the urinary catheter is removed, and a stoma nurse works with the patient on ostomy care. The expectation is that the patient will be out of bed, and physical therapy consulted for those who require it. Postoperative day 2 brings transition to oral pain medication and removal of epidural catheter if a diet has been tolerated. Once the patient is comfortable with their pain management, understands how to manage their ostomy, is tolerating a diet, and able to complete their activities of daily living, they are discharged from the hospital.

Conclusions

While UC is managed with improving medical therapies all patients require endoscopic oncologic surveillance, and nearly half will require operative intervention for sequela of the disease. Improved resection techniques that are

sphincter preserving and minimally invasive in nature have led to improved quality of life for patients with UC while mitigating, eliminating, or treating oncologic risk.

Suggested Reading

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54 Colonic Conditions: Indeterminate Colitis

Jon D. Vogel and Mariana Berho

See Algorithm in Fig. 54.1

A. Similar to ulcerative colitis or Crohn's colitis, patients with IC or IBDU typically have symptoms of diarrhea, blood in the stool, abdominal pain, fecal urgency, and tenesmus. With each of these colitides, severe or fulminant presentations may occur.
B. A detailed medical and family history is performed to search for clues that implicate Crohn's disease as the underlying pathology. Prior small bowel obstruction, obstructive symptoms, or perianal disease are suggestive of Crohn's disease. Symptoms of extraintestinal disease and family history of IBD are also assessed. Colitis disease severity may be estimated by stool frequency, blood in the stool, weight loss, anemia, or signs of "toxicity" such as fever, tachycardia, or hypotension.
C. The physical examination is used to assess colitis severity (e.g. abdominal distension or tenderness), and to look for clues of Crohn's disease such as palpable abdominal mass, edematous anal skin tags, perianal abscess or fistula, anal stenosis, or scars from prior anorectal surgery.
D. A complete blood count and serum albumin measurement are helpful to determine the severity and chronicity of IBD-UC/IC. Stool testing is performed to exclude *Clostridium difficile* infection or other infectious etiologies of colitis. Serological biomarkers, such as p-ANCA and ASCA, and genetic markers, such as NOD2/CARD 15, are generally not useful to establish the specific type of IBD.
E. CT or MR enterography are selectively used to exclude the presence of small bowel disease or segmental colorectal disease that are suggestive of CD. In acutely ill patients, plain abdominal radiographs are used to exclude megacolon or pneumoperitoneum.
F. Colonoscopy is used to evaluate the severity and extent of colitis. Rectal sparing, segmental inflammation, deep or linear ulcers, ileocecal valve or terminal ileal ulceration, erythema, edema, or strictures are endoscopic findings indicative of Crohn's disease. Alternatively, gross inflammation that starts in the rectum and extends proximally in a continuous pattern and then transitions to normal appearing mucosa is characteristic of ulcerative colitis. Backwash ileitis, or continuous inflammation of the terminal ileum without focal ulceration or strictures, may occur with ulcerative colitis. A discontinuous "cecal patch" of inflammation, that is limited

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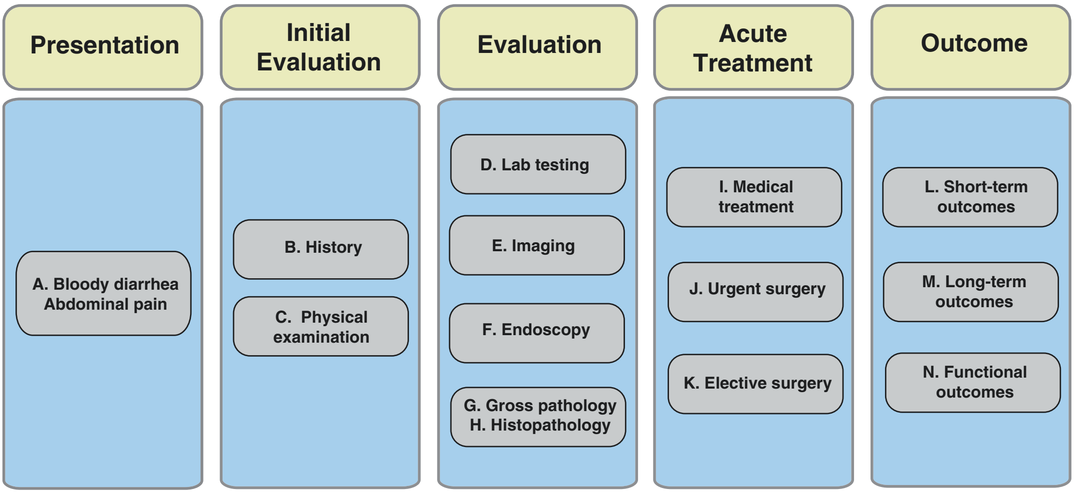

Fig. 54.1 Algorithm for indeterminate colitis

to the mucosa immediately surrounding the appendiceal orifice, may also be seen in UC. It is important to also note that medical treatment of UC may result in segmental colorectal mucosal changes and the false impression that CD is the underlying disease. Mucosal biopsies are obtained for histologic assessment of inflammation, cytomegalovirus (CMV) infection, dysplasia, or cancer.

G. Inflammatory bowel disease—unclassified (IBD-U) is the term to describe biopsy specimens with inflammatory bowel disease in which a definitive diagnosis of Crohn's disease or ulcerative colitis cannot be made with certainty. A diagnosis of indeterminate colitis (IC) is based on the pathological analysis of a colectomy specimen. Macroscopic pathological features of Crohn's disease include mesenteric fat wrapping of the bowel wall, "skip areas" of inflamed and normal-appearing mucosa, segmental rather than continuous mucosal inflammation, small bowel involvement beyond what is typical for "backwash ileitis" (continuous inflammation of the terminal ileal mucosa without stricture or deep ulceration), fistula, stricture, cobblestone appearance of the intestinal mucosa, transmural inflammation, and perianal disease. Grossly, ulcerative colitis is characterized by continuous mucosal inflammation that begins in the rectum and "spreads like a sheet" into the more proximal colon. Mesenteric fat wrapping or segmental colonic mucosal inflammation, in the absence of other distinct features Crohn's disease or ulcerative colitis, raise the specter of indeterminate colitis (Table 54.1, Fig. 54.2).

H. Histological features of Crohn's disease include non-caseating granulomas (identified in 20% of biopsy specimens and 50% colectomy specimens), and aphthous ulcers. These findings are inconsistent with a diagnosis of ulcerative colitis or indeterminate colitis. Nerve cell hyperplasia and vasculitis may be seen in Crohn's disease or ulcerative colitis but are more common in Crohn's disease. Transmural inflammation occurs in Crohn's disease but may also be present with severe colitis due to ulcerative or indeterminate colitis (Table 54.2, Fig. 54.3).

I. The medical treatment of UC, CD, and IBD-U/IC are similar and typically include the 5-ASA drugs, glucocorticoids, azathioprine, and biologic therapies targeted at TNF-alpha or intestinal mucosal integrin. Supportive therapy with intravenous fluids, antibiotic treatment of clostridium difficile as needed, and the use of antibiotics to treat suspected or proven infectious processes that complicate IBD colitis may also be required.

Table 54.1 Macroscopic features useful to distinguish ulcerative colitis from Crohn's disease

	Ulcerative colitis	Crohn's disease	Indeterminate colitis	Caveats
Fat wrapping	No	Yes	Occasionally in areas of deep ulceration	– Severe cases of UC with deep ulcers may display fat wrapping
Segmental involvement/rectal sparing	No	Yes	Common	– Medical treatment in UC may lead to uneven healing and areas of "pseudosparing"
Small intestinal involvement	No	Yes	No	– UC may display "backwash ileitis"[a] – Up to 20% of cases of CD present with colonic involvement only
Fistulas	No	Yes	No	
Cobblestone appearance	No	Yes	No	
Predominantly distal disease	Yes	No	No	– UC may show discontinuous involvement of the cecum (cecal patch)
Anal/perianal disease	No	Yes[b]	No	

[a]A diagnosis of backwash ileitis should be limited to those cases with a mild inflammation limited to the distal 5 cm of the terminal ileum, the presence of deep ulceration should raise the possibility of Crohn's disease

[b]The presence of anal/perianal disease should strongly raise the possibility of Crohn's disease even when the rest of the pathological changes are equivocal

Fig. 54.2 Indeterminate colitis

Venous thromboembolism prophylaxis is also generally recommended in hospitalized patients with IBD.

J. Urgent subtotal or total abdominal colectomy with ileostomy is generally indicated for IBD-U complicated by severe colitis refractory to medical therapy, megacolon, colonic perforation, or hemorrhage. Open or minimally invasive surgical techniques may be used. Preservation of the inferior mesenteric artery pedicle and the distal sigmoid colon facilitates subcutaneous implantation of the stapled sigmoid stump or creation of a sigmoid mucous fistula when necessary (e.g. severely edematous distal colon) and also simplifies subsequent proctectomy via preservation natural tissue planes. Rectal resection is usually avoided in the acute setting to minimize potential complications of surgery and to allow pathology review of the resected colon to help solidify the diagnosis.

K. Proctocolectomy with ileal pouch anal anastomosis (IPAA) may be performed in carefully selected patients with IBD colitis in whom the diagnosis of CD, particularly small bowel or perianal CD, has been excluded. Open or minimally invasive surgical techniques may be used. The decision to perform a one- or multi-staged proctocolectomy should be an individualized decision with consideration of the risks and benefits associated with each approach. In general, staged IPAA procedures, with initial subtotal colectomy and end ileostomy, are performed in patients who are malnourished, on high-doses of steroids, or have findings at surgery, such as extraordinary fragility of the tissues and bleeding during the colectomy. Subtotal or total abdominal colectomy with end ileostomy is also recommended when the operative findings are suspicious for Crohn's disease. In this situation, pathology review of the colectomy specimen will often help guide

Table 54.2 Microscopic features useful to distinguish ulcerative colitis from Crohn's disease

	Ulcerative colitis	Crohn's disease	Indeterminate colitis	Caveats
Granulomas	No	Yes Only 20% of biopsies and approximately 50 to 60% of surgical specimens	No	Ruptured crypts secondary to inflammation may show granulomatous reaction in ulcerative colitis
Transmural inflammation	No	Yes	Common	Severe UC may display transmural inflammation in areas of deep ulcers
Aphthous ulcers	No	Yes	No	
Nerve cell hyperplasia	+	+++	No	
Vasculitis	+	+++	No	

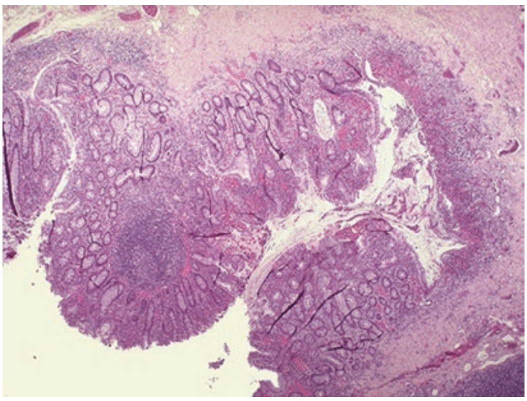

Fig. 54.3 Deep ulceration

future surgical decisions. Proctolectomy with permanent ileostomy may be appropriate for elderly patients, or those who have impaired anal sphincter function, or for patients who have other reasons for which an ileo-anal reservoir is a poor choice. Total abdominal colectomy with ileorectal anastomosis may also be considered in select patients with a grossly normal and dysplasia-free rectum who accept the risk of proctitis, the need for subsequent medical or surgical therapy for the rectum, and who are compliant with rectal mucosa surveillance.

L. In the series reported by Yu, Brown, and Delaney, early postoperative complications of IPPA surgery, including pelvic sepsis and fistula formation, but not anastomotic leak, occurred more often in IC compared to UC patients. In Dayton's series, there were no differences in early postoperative IPAA complications

M. Long-term outcomes of IPAA for IC compared to UC vary and include an eventual change in the diagnosis to Crohn's disease in 1–15% of patients and pouch failure (requiring diverting ileostomy or pouch excision) in 2–23% of patients. With 10-year follow-up, Yu reported significantly more long-term complications in IC patients compared to UC including pelvic sepsis, pouch fistula, and pouch failure (23% vs. 9%). More recently, Murrell and colleagues reported similar IPAA outcomes for their IC and UC patients with conversion to a diagnosis of CD in 14 (14%) of 98 patients with IC, and 29 (11%) of 236 patients with UC (Table 54.3). Pouchitis occurs with similar frequency among patients with UC and IC (Yu, Dayton, Murrell). In patients with an IPAA who convert from a diagnosis of IC to CD, pelvic perineal sepsis is treated with antibiotics, incision and drainage, and liberal use of draining setons. Mucosal inflammation or fistulizing disease is initially treated with the full spectrum of Crohn's disease medical therapy. In patients in whom the above interventions fail, the use of a diverting ileostomy or excision of the ileal pouch with permanent ileostomy must be considered.

N. In a study from the Cleveland Clinic (Delaney), in which 115 IC and 1399 UC

Table 54.3 Published series on indeterminate colitis

Author	Year	IC patients (N)	IC → CD (%)	IC w/IPAA failure (%)	UC patients (N)	UC → CD (%)	UC w/IPAA failure (%)
Marcello	1997	53	13	12	499	3	2
Yu	2000	82	15	23	1437	2	9
Delaney	2002	115	6	3	1399	1.3	3.5
Dayton	2002	79	1	2.5	565	0.7	1.2
Brown	2005	21	0	10	1135	NA	6
Murrell	2009	97	14	NA	237	11	NA

Table modified from C. Delaney et al. 2002
IC patients indeterminate colitis patients, *IC → CD* IC patients subsequently diagnosed with Crohn's Disease, *IC w/IPAA failure* patients with IC and IPAA with subsequent IPAA excision or permanent ileostomy, *UC patients* ulcerative colitis patients, *UC → CD* UC patients subsequently diagnosed with Crohn's disease, *UC w/IPAA failure* patients with UC and IPAA with subsequent IPAA excision or permanent ileostomy

patients who underwent IPAA, the functional outcomes were largely similar for the two diagnoses. Daytime bowel movements numbered 4–8 and nighttime were 0–2. The majority (70–74%) reported rare or no fecal incontinence and nighttime stool seepage occurred in about one-third of IC and UC patients. Similar functional results for IPAA in UC and IC have also been reported by surgeons from the University of Toronto (Brown), Louisville (Rudolph), Utah (Dayton) and the Mayo Clinic (Yu).

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55 Colonic Conditions: Toxic Colitis

Carmen Fong and Benjamin Abbadessa

Refer to Algorithm in Fig. 55.1

A. History and Physical
   1. *Clostridium difficile* Infection (CDI, Pseudomembranous colitis) is the leading cause of infectious diarrhea in the world, and has become increasingly more prevalent and severe. Two prevalent theories behind *C. difficile*-associated toxic colitis are that *C. difficile* exotoxin causes either inflammatory infiltrates in the myenteric plexus which lead to smooth muscle damage, or inflammatory mediators such as nitric oxide cause smooth muscle relaxation, both resulting in dilation and distension of the large bowel.

      CDI may present with abdominal pain, bloating, diarrhea (occasionally bloody), and subjective fever and chills. However, one study quotes up to 40% of patients may present with the obstipation form of CDI and may not have diarrhea. On physical exam, the patient may have marked abdominal tenderness and distension. In the most severe cases, the patient may also be febrile, dehydrated and septic with profound leukocytosis. One report found that 96% of cases of the disease are associated with use of antibiotics such as ciprofloxacin or clindamycin within the last 14 days. Symptoms usually appear 2–3 days after initiation of antibiotic therapy. Other risk factors include IBD, recent travel, HIV seropositivity, malnutrition, advanced age and acid suppression with a proton pump inhibitor.
   2. Ulcerative Colitis (UC) is an autoimmune disease characterized by chronic mucosal-based inflammation of the colon. The disease begins in the rectum and may extend proximally in a continuous manner to involve all or part of the colon. The small bowel and terminal ileum are not involved but may show patterns of mucosal inflammation due to local inflammatory factors associated with backwash ileitis. Patients typically present with bloody diarrheal stools. Abdominal pain is most common with moderate and severe UC. On physical exam, patients with severe UC may present with fever, leukocytosis, abdominal tenderness and distension. Most patients' disease course will involve remissions and exacerbations.
   3. Crohn's Disease (CD) is a trans-mural, autoimmune process that can affect the entire length of the intestinal tract in a discontinuous manner. The most common involved locations include the terminal ileum (30%), ano-rectum and colon (20%) and combined small bowel and colon

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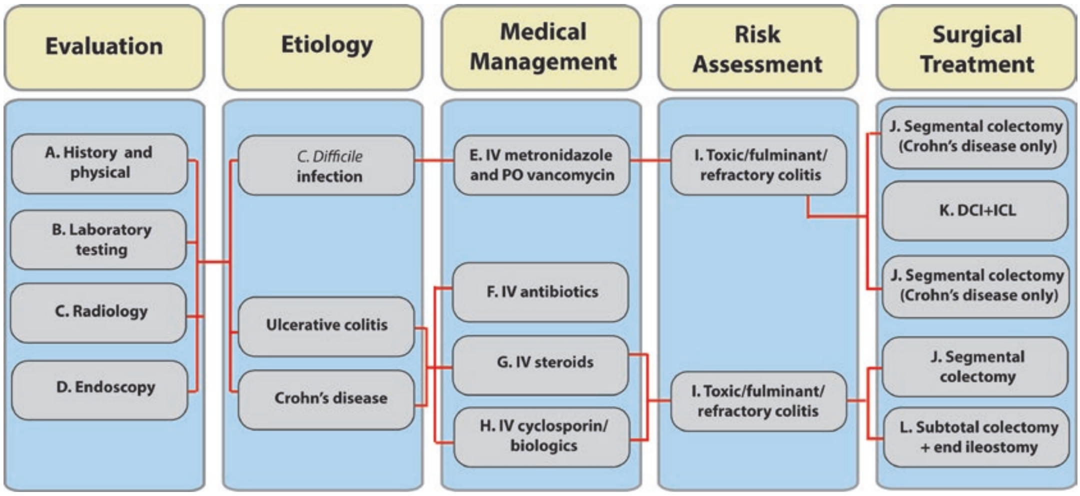

Fig. 55.1 Algorithm for treatment of toxic colitis. *DLI* diverting loop ileostomy, *ICL* intraoperative colonic lavage

disease (50%). CD has an incidence of 2–4 patients per 100,000 in the Caucasian population. It is more common in Ashkenazi Jews, and 20 times more prevalent in patients with a family history. Patients are more likely to be female and tend to have a bimodal distribution of age at presentation. The typical presentation includes abdominal pain that is vague, crampy and intermittent. There may be hematochezia. Severe colitis may present as, or progress to, major lower GI bleeding, perforation, obstruction, or fulminant colitis. Extra-intestinal manifestations are more frequent in Crohn's disease than Ulcerative colitis and include ocular, bone, hepatobiliary and cutaneous manifestations. On physical exam, the patient may look toxic, with fever, leukocytosis, abdominal tenderness and distention.

B. Laboratory Testing

A complete blood count as well as a complete metabolic panel should be obtained, as well as inflammatory markers such as erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP). An elevated ESR and CRP can signify disease.

Stool studies including tests for *C. difficile*, cytomegalovirus, ova and parasites, and stool leukocytes are important tools in diagnosis, and help differentiate between infectious and non-infectious causes of toxic colitis. Within stool testing for *C. difficile*, there are various modalities. A positive stool culture indicates the presence of *C. difficile* bacterium, whereas a positive stool toxin indicates clinically significant disease. Cell cytotoxicity assays, which test for toxins A&B, have sensitivities between 60% and 100%. The US Department of Health recommends a 2-stage test approach involving enzyme immunoassay (EIA) glutamate dehydrogenase testing followed by cell cytotoxicity or cultures. This approach has >90% sensitivity and specificity. A relatively new modality, based on polymerase chain reaction (PCR) testing of toxin genes, called nucleic acid amplification tests (NAAT) is gaining popularity as a faster and more reliable method of diagnosis which may replace the two-step method, as it has a 94–99% sensitivity rate.

Lastly, PCR for CMV has a sensitivity and specificity in the blood of 45% and 87%, a mucosal biopsy sensitivity of 90%, and sensitivity in stool of 67%, but nonetheless remains an important differential diagnosis.

C. Imaging

A CT scan is a useful tool in evaluation of abdominal pain (Fig. 55.2). While

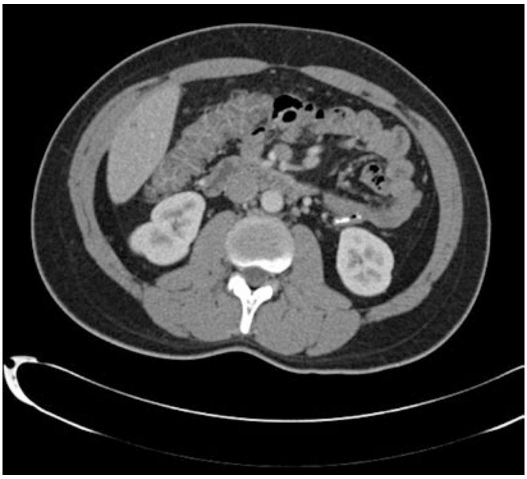

Fig. 55.2 CT findings of pancolitis

the sensitivity and specificity of CT scan in diagnosing toxic colitis is low (52–85% and 48–92%), and approximately 40% of patients with toxic colitis will have normal CT scans, imaging can be useful in identifying the affected portions of colon, as well noting non-specific signs of inflammation. Findings of severe colitis may include colonic wall thickening, ascites, mesenteric fat stranding, and colonic wall enhancement. Pathognomonic CT features of toxic megacolon include air-filled colonic distension >6 cm, an abnormal haustral pattern and wall thickening. The presence of mesenteric venous gas, pneumatosis intestinalis, or pneumoperitoneum is a sign of severe disease.

Abdominal radiographs, while less diagnostic, are useful, rapid adjuncts to diagnosis. An X-ray may show colonic distension, wall-thickening, and air-fluid levels.

D. Endoscopy

Endoscopy may be a useful adjunct in the diagnosis of toxic colitis. In infectious colitis, colonoscopy may show a pseudo-membrane. Pseudomembranous colitis is most commonly seen in *C. difficile* infection, however CMV is also a lesser-known cause. Cytomegalovirus (CMV), in the last ten years, has been increasingly recognized as a rare but morbid condition that may co-exist with CDI, especially in immune-compromised or elderly patients. CMV is most accurately diagnosed with endoscopic biopsy and should be treated if positive.

Classic endoscopic findings for UC include continuous friability, bowel wall edema, confluent erythema, and loss of vascular markings. Advanced stages may demonstrate ulceration, purulence and pseudo-polyp formation. Classic findings on endoscopy for Crohn's disease include 'skip lesions' and a 'cobblestone' appearance, as well as patchy erythema and aphthous ulceration. Advanced disease may show confluent ulcers, stricturing and mucosal bridging.

In the setting of severe colitis, fulminant colitis or toxic megacolon, endoscopy is contraindicated due to the high risk of perforation.

Medical Management

The goals of medical management of toxic colitis, regardless of etiology, should be aimed at stabilizing the patient, correcting fluid and electrolyte disturbances, and treating the underlying disease process. Initial resuscitation should include aggressive fluid replacement, transfusion if necessary, electrolyte repletion, and broad spectrum disease-specific antibiotic coverage. Medications that affect colonic motility should be discontinued. The patient should be admitted to an intensive care unit or a monitored setting, with Foley catheter insertion, strict I&Os, bowel rest and as needed nasogastric tube decompression.

E. PO Vancomycin and IV Flagyl for CDI

Antibiotic therapy for severe CDI is based on oral vancomycin 125–500 mg four times daily and intravenous metronidazole 500 mg three times daily. The clinical success rate is 66.3% for metronidazole vs. 78.5% for vancomycin for severe CDI. Vancomycin enemas have also been used as an adjunct to primary therapy with success rates up to 70%.

F. IV Antibiotics for IBD

Antibiotic coverage should include broad-spectrum coverage for colonic bacterial supra-infection or translocation.

G. Intravenous Steroids in IBD

In patients with IBD and toxic colitis, high-dose intravenous steroids have been shown to be useful in avoiding colectomy in the short term in up to 25% of patients. Steroids should only be used as initial management and is not indicated in unstable patients or patients with free perforation or bowel ischemia or progressive colonic dilation. Sample regimens include hydrocortisone 100 mg every 6 h, methylprednisolone 16–20 mg every 8 h, or prednisolone 20 mg every 8 h.

H. IV Cyclosporine/Biologic Agents in IBD

In patients who do not show clinical improvement within 3–5 days after initiation of steroid therapy, cyclosporine may be used as a rescue therapy in doses of 4 mg/kg/day intravenously while maintaining high-dose intravenous steroids. This combination has a 67% response rate in the literature.

Marion et al. found that with the addition of 6-MP, 78% of cyclosporine responders avoided colectomy whereas only 36% of patients who did not receive 6-MP avoided surgery. Marion recommends the addition of 6-MP to all cyclosporine responders. Side effects of cyclosporine include renal toxicity, seizures, hypertension and opportunistic infections.

Biologics can also be considered as rescue therapy in patients who have failed treatment with intravenous steroids. In the literature, avoidance of colectomy can range from 25% to 90% of patients.

Risk Assessment

Mild to severe ulcerative colitis and Crohn's colitis can be defined by the Truelove and Witts score (see Table 55.1), which incorporates vital signs, clinical and laboratory data. Utilizing the same parameters, fulminant colitis has been described by Jones et al. as fever, tachycardia, elevated ESR, >10 bloody bowel movements daily, continuous bleeding requiring blood transfusion, abdominal tenderness and distension as well as imaging evidence of colonic dilation.

Table 55.1 Truelove and Witts score for inflammatory bowel disease severity

	Mild	Moderate	Severe
Bowel movements (no. per day)	Fewer than 4	4–6	Six or more plus at least one of the features of systemic upset
Blood in stools	No more than small amounts of blood	Between mild and severe	Visible blood
Pyrexia (temperature greater than 37.8 °C)	No	No	Yes
Pulse rate greater than 90 bpm	No	No	Yes
Anemia (<10 g/100 mL)	No	No	Yes
Erythrocyte sedimentation rate (mm/h)	30 or below	30 or below	Above 30

I. Toxic/Fulminant/Refractory Colitis

Regardless of the etiology, early surgical consultation is essential for patients with toxic colitis. Absolute indications for surgery include free perforation, massive hemorrhage (requiring greater than 6 units packed red blood cells), increasing toxicity (fever, leukocytosis, hypotension, tachycardia), and worsening colonic dilation. While older epithets advised conservative management for up to 1 week in the absence of disease progression, failure to improve after 48–72 h of medical management is a relative indication for surgery. Lower mortality rates have been associated with early surgery—4% mortality in non-perforated toxic colitis compared to 20% mortality in perforated toxic colitis.

Surgical Management

There are many different operative approaches for toxic colitis. Early on, total procto-colectomy was the procedure of choice, but this has fallen out of favor because of the increased morbidity and mortality of operating in the pelvis, including increased risk of blood loss, sepsis, nerve damage, and small bowel obstruction. Three other approaches are described here, with the rationale and evidence for each.

J. Segmental Colectomy

There is no evidence in the literature to support a segmental colectomy in toxic megacolon or pancolitis. The pathophysiology of the disease does not support segmental resection, since toxic colitis can severely affect the entire colon and mucosal inflammation may not be apparent on visual inspection of the serosa. In the rare setting of perforated segmental Crohn's toxic colitis, a segmental colonic resection with fecal diversion has been performed for colon-sparing purposes. There has not been long-term follow-up regarding need for further resection or recurrence in these patients.

K. DLI + ICL

Historically, the Turnbull-Blowhole colostomy was described in 1971 to temporize patients with toxic megacolon due to IBD. This was a skin level colostomy and loop ileostomy used for colonic decompression and diversion. A more recent case series out of the University of Pittsburgh, published in 2011, built upon this technique and looked specifically at *C. difficile* infection.

The Pittsburgh study treated 42 patients over a two-year period from 2009 to 2011 and found that diverting loop ileostomy and intra-operative colonic lavage (DLI + ICL) was a safe and colon-sparing alternative to the gold standard of subtotal colectomy with end ileostomy (SC + I). In their study, patients who came in with severe, fulminant CDI were taken to the operating room where a diverting loop ileostomy was created, and the colon was lavaged intra-operatively with warmed polyethylene glycol solution (8 L) via the defunctionalized limb of the ileostomy. Post-operatively, patients were given antegrade vancomycin flushes (500 mg q8 h) for 10 days while being treated with intravenous metronidazole. Eighty-three percent of the patients were treated laparoscopically.

The patients treated with DLI + ICL were matched to historic controls treated with subtotal colectomy and end ileostomy and were found to have a statistically significant shorter time to normalization of leukocytosis (5.9 days), shorter time to return of bowel function (2.6 days), a higher chance of ileostomy reversal (20% vs. 79%), and overall decreased mortality (19% vs. 50%). Only 3 out of the 35 patients (8%) who underwent laparoscopic DLI + ICL proceeded to require colectomy, either for abdominal compartment syndrome or recurrent vasopressor requirement. The colon was preserved in 39 out of 42 patients (93%).

Two small case series have attempted to validate the Pittsburgh results but this has not been replicated. In one study from Johnstown, PA, where two surgeons performed open DLI + ICL, three out of four patients showed clinical improvement post-operatively, and one patient expired post-operatively. The general consensus is that more prospective, randomized studies need to be done.

L. Total Abdominal/Subtotal Colectomy + End Ileostomy

Subtotal colectomy with end ileostomy is the gold standard in the surgical treatment of toxic colitis. It was first described by Crile in 1951, as the treatment for a case of acute toxic ulcerative colitis.

In severely ill patients with distended bowel, an open approach tends to be safest and most efficacious. The incision should be of adequate length to facilitate easy access to and mobilization of the colon in a lateral-to-medial fashion, with care taken to avoid perforation and intra-abdominal contamination, as the bowel will likely be friable and edematous.

The mesentery and its vessels are divided close to the bowel wall. The small bowel is divided immediately proximal to the ileocecal valve to preserve the maximum length of small intestine for potential future reconstructive options. The colon is divided at the recto-sigmoid or distal sigmoid depending on the condition of the bowel. To prevent stump blowout, some surgeons reinforce the rectal stump staple line by over-sewing it and others prefer a longer Hartmann pouch brought up to the skin. In the latter technique, the sigmoid colon is exteriorized at the inferior portion of the midline wound and sutured to the fascial edges while the intact staple line remains above the level of the fascia and in the subcutaneous tissue. In one 2011 study from the Cleveland Clinic, the postoperative outcomes were found to be comparable whether the rectal stump was intraperitoneal or subcutaneous. Subcutaneous placement of the rectal stump was associated with a higher wound infection rate (13% vs. 5%), but this is considered to be less morbid than a rectal stump leak leading to pelvic sepsis. Transrectal drainage of the subcutaneous or rectal stump is also a decompressive option. The end ileostomy is then delivered through the rectus muscle and matured to 2 cm in a Brooke-type fashion. Timing of reversal of the stoma is based on patient factors and the underlying disease; generally the time frame is 3–6 months.

Reconstructive options for UC include completion proctectomy with ileal pouch anal anastomosis (IPAA). In CDI, an ileorectal anastomosis can be performed. In Crohn's disease with active anal or rectal disease, reconstruction is not recommended; in Crohn's patients without active anal or rectal disease, a ileorectal anastomosis can be considered.

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Crohn's Colitis

56

Meagan M. Costedio and Leonardo C. Duraes

Refer to Algorithms in Figs. 56.1 and 56.2

A. Crohn's disease (CD) is an inflammatory disorder of unknown etiology that is thought to be related to genetic and environmental factors. It is estimated that 780,000 Americans currently have CD. The incidence of new cases of CD diagnosed each year is approximately 10.7 per 100,000 people. CD can occur at any age; however, people are most frequently diagnosed between 15 and 35 years old. It is predominantly observed in developed countries. CD may involve any portion of GI system. Sixty percent of CD patients have colonic involvement. Half of those have disease in the colon only, half of whom have synchronous involvement of the small intestine.

B. CD symptoms are heterogeneous. Chronic diarrhea is the most common symptom, followed by abdominal pain, weight loss, and blood and mucus in the stool which is seen in up to half of patients. Extra-intestinal manifestations are most common when CD affects the colon. Musculoskeletal system abnormalities encompassing peripheral and axial joints are the most common extra-intestinal manifestations, however dermatologic, oral, hepatopancreatobiliary, ocular, pulmonary or renal systems can also be involved. Perianal fistulas are present in 10% of patients at the time of diagnosis, and can be the presenting symptom. Many patients have developed other medical complications of disease including malnutrition, adrenal insufficiency and anemia.

C. CD can present with a variety of complex phenotypes. Therefore, the diagnosis depends on a combination of clinical evaluation, endoscopic appearance, histological, radiological, surgical findings, and biochemical investigation. The differential diagnosis of CD colitis includes ulcerative colitis (UC), indeterminate colitis, appendicitis, irritable bowel syndrome, microscopic colitis, infectious colitis, ischemic colitis, idiopathic colitis and cancer. When the disease is restricted to the colon, it may be difficult to differentiate from UC. Ten to twenty percent of cases of colitis cannot be classified and they are labeled indeterminate colitis.

D. Colonoscopy with multiple biopsies is the first line procedure for diagnosing colitis. Endoscopic features pathognomonic for CD are discontinuous involvement, anal lesions

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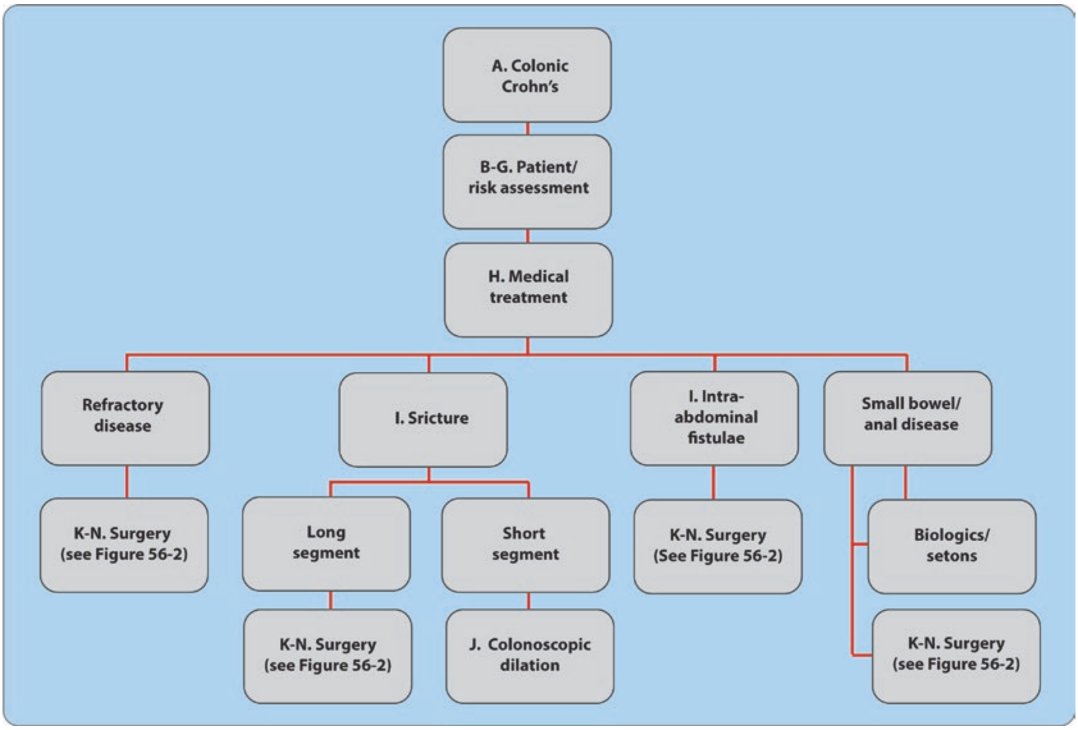

Fig. 56.1 Algorithm for management of Crohn's colitis

and cobblestoning. Ileoscopy with biopsy increases the diagnostic yield of CD. Histologically, the finding of noncryptolytic granulomas, focal or patchy lamina propria chronic inflammation, focal or anatomically discontinuous crypt distortion, and ileal involvement solidify CD diagnosis. MR or CT enterography have high accuracy for the detection of small bowel involvement of CD, including extramural complications such as fistulae or abscesses. Abdominal X ray is used to evaluate for colonic distention. CT scans are helpful in the diagnosis of abscesses and or fistulae. Serological biomarkers, including pANCA, ASCA, anti-CBir1, anti-I2 and anti-OMPC, may be used to help with differential diagnosis among more common bowel diseases, especially in pediatric population. Elevated ASCA has 50–70% of sensitivity, and 80–85% of specificity for CD. On the other hand, elevated pANCA has a prevalence of only 6–20% in CD, but 65–70% of sensitivity and 80–85% of specificity for UC. Fecal calprotectin has been shown to reflect the severity of mucosal inflammation in inflammatory bowel diseases (IBD), and was shown to predict the relapse of CD. Anal examination is essential to diagnosis of anal CD. The most common anal presentations of CD are perianal abscess, anal fistula, atypical anal fissure and sentinel tags. A minority of patients present with high/complex anal fistulae, or recto-vaginal fistulae.

E. CD has been classified by disease phenotype (Montreal classification), by disease activity (Crohn's Disease Activity Index—CDAI), and response to therapy (steroid-resistant or steroid-dependent). The Montreal classification categorizes CD according to patient age (16 years and younger—A1, 17–40 years—A2, over 40 years—A3), disease location (terminal ileum—L1, colon—L2, ileocolon—L3, upper GI location—L4), disease behavior (non-stricturing, non-penetrating—B1, stricturing—B2, penetrating—B3). CD phenotype may be used to elect appropriate surgical treatment. Sustained disabling symp-

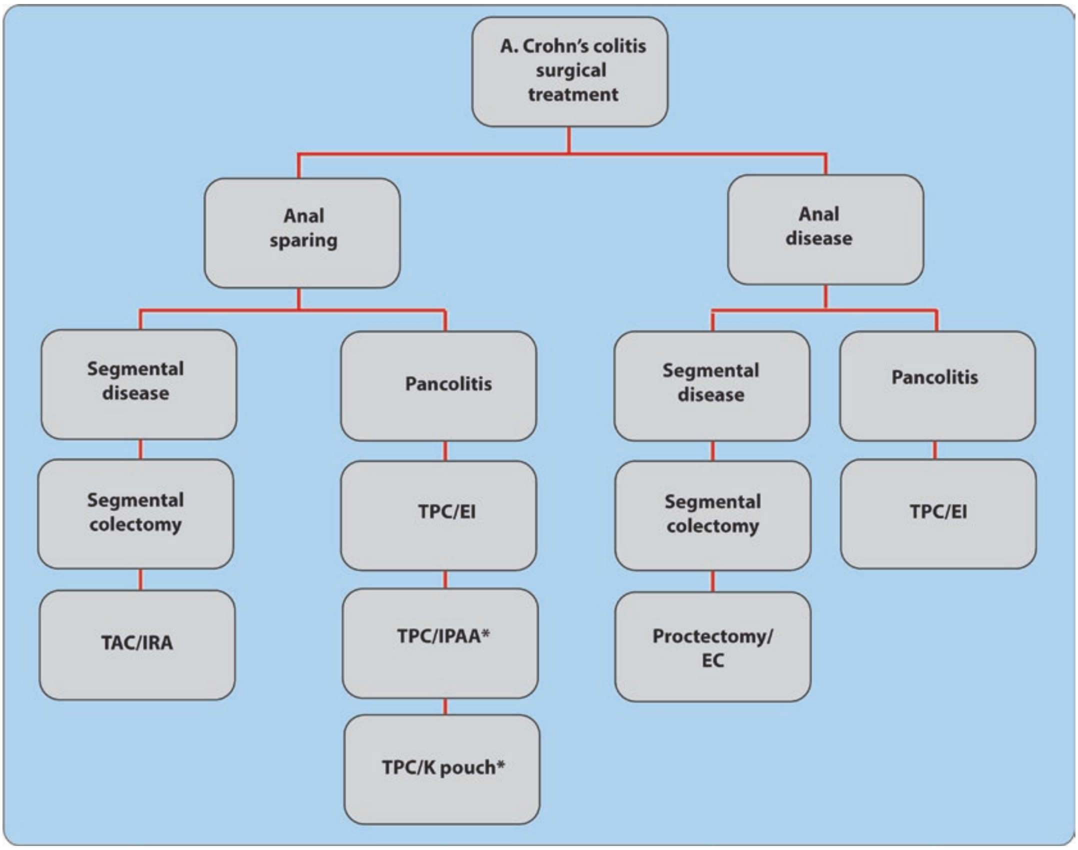

Fig. 56.2 Algorithm for surgical treatment of Crohn's colitis. *TAC/IRA* total abdominal colectomy with ileo-rectal anastomosis, *TPC/IPAA* restorative total procto-colectomy with ileal pouch-anal anastomosis, *TPC/EI* total proctocolectomy with end ileostomy, *TPC/K pouch* total proctocolectomy with continent ileostomy (K pouch), *EC* end colostomy. (*Asterisk*) Very rarely in highly selected well-informed patients

toms, impaired quality of life, abscesses, fistulae, obstruction, inability to wean from steroids and need for surgery are factors used for clinically defining CD severity.

F. CD is associated with several complications, such as perforation, abscesses, fistulas, strictures, obstruction, malnutrition, hemorrhage, dysplasia, cancer, and toxic colitis. Patients with free perforation or toxic megacolon need emergent surgical treatment. Due to improved medical therapies, surgical management is more commonly used to manage complications. Patients with enteric fistulae with symptoms require a resection. Intra-abdominal abscesses can be treated with IV antibiotics and CT scan guided drainage. If the abscess responds, surgery can often be delayed. Patients with long-standing CD have high risk of dysplasia and cancer. Patients with carcinoma, dysplasia-associated lesion or mass (DALM), high-grade dysplasia, or multifocal, low-grade dysplasia of the colon or rectum should undergo oncologic total proctocolectomy.

G. Medical treatment should take into consideration activity, site and behavior of CD. The medication choice is also influenced by previous response to treatment, potential side-effects, complications, and extra-intestinal manifestations. Colonic CD activity and severity is easier to assess by colonoscopy than other areas. For colonic CD, systemic corticosteroids remain the first-line therapy for acute exacerbations. For distal disease, topical therapy is an option such as mesalamine or steroid enemas. The use of

sulfasalazine, metronidazole, or dietary changes are useful in mildly active disease. Once the acute flare is managed, immunomodulators are an option for patients with moderate to severe active disease. Recently, biologic therapies are being used in the early phase of the disease. Traditionally, anti-TNF agents have been indicated for patients that have persistent symptoms and unable to wean from steroids. However, efforts are being made to identify patients with aggressive disease, such as penetrating or anal disease, who may benefit from early introduction of biologics, and change the pattern of future disease.

H. Both diagnostic and therapeutic endoscopy are important tools in the management of CD. Endoscopic dilation and biopsy of stenoses in CD is the preferred technique for the management of accessible short segment strictures. Dilation carries a risk of perforation, and should be performed in institutions with surgical back-up. Surgery should be reserved for longer strictures, failed endoscopic treatment, or if there is concern for cancer. Colonoscopy is used to monitor disease response to therapy as well as monitor for dysplasia or malignancy in patients with long-standing CD. According to AGA guidelines, patients with Crohn's colitis who have disease involving at least one third of the length of the colon, should undergo a screening colonoscopy a maximum of 8 years after onset of symptoms, with four biopsies every 10 cm throughout the entire colon. After two negative examinations (no dysplasia or cancer), further surveillance examinations should be performed every 1–3 years.

I. Surgical treatment has evolved due to recent developments in medical therapy. Surgery is most often performed in cases of failure of medical treatment or disease complications. Therefore, patients referred to surgery have complicated disease, and or a higher perioperative risk due to medical comorbidities. Unlike small bowel CD, there is less of need to preserve the large bowel during surgery. Surgical strategy is mainly based on location and duration of disease, urgency of intervention, presence of complications, and the general condition of the patient. Patients with abscesses, internal fistulas, or stenosis are considered for surgery at an earlier stage of the disease. Nutritional, medical, social and psychological factors need to be considered in the surgical treatment plan. Smoking is a major factor for recurrence, and patients should be strongly encouraged to stop smoking before surgery.

J. When a patient with colonic CD requires emergent or urgent surgery, subtotal or total colectomy with end ileostomy with Hartmann's closure of the distal bowel or creation of mucous fistula is the safest procedure, particularly in cases of failure of medical therapy when the patients are physiologically ill. In patients not taking immunomodulating agents who have acute perforation and are otherwise well, segmental resection with primary anastomosis with or without diverting loop ileostomy is an option.

K. For localized colonic disease involving less than a third of the colon, segmental colectomy is preferable. This approach has lower risk of permanent stoma, but higher risk of recurrence compared to total proctocolectomy. Multi-segment colonic disease with rectal sparing can be treated with subtotal colectomy with ileo-rectal anastomosis or multiple segmental resections. The minimally invasive approach has proven short term recovery benefits as well as the long term benefit of decreased adhesions for future surgeries. That being said Crohn's disease can be challenging laparoscopically and requires advanced technical skill and surgeon comfort. Stricturoplasty is not recommended due to the increased risk of cancer in a colonic stricture. In patients with pancolitis where the rectum is spared, total abdominal colectomy with ileo-rectal anastomosis is the preferred surgical option.

L. In patients with pancolitis and small bowel and anal sparing, restorative proctocolectomy with ileo pouch-anal anastomosis (IPAA) or Koch pouch may be an option to avoid permanent ileostomy. However, IPAA

in Crohn's carries higher complication and pouch failure rates compared to UC or indeterminate colitis. This option may be offered on very rare occasions to well informed patients. Its widespread use is not encouraged. Total proctocolectomy with end ileostomy is the only surgical option for patients with pancolitis and anal or small bowel involvement.

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57 Ischemic Colitis

Alodia Gabre-Kidan and David J. Maron

Refer to Algorithm in Fig. 57.1

A. Colonic ischemia is the most common form of intestinal ischemia with an estimated incidence of 7–16/100,000-patient years. While colonic ischemia can present as severe, life-threatening disease, most cases are mild, self-limited, and reversible. Given its transient nature, many patients may not even seek medical attention, which leads to a likely underestimation of the true incidence in the medical literature.

B. The most common presenting symptoms in patients with colonic ischemia are abdominal pain over the affected portion of the colon, an urge to defecate, and bloody diarrhea. None of these findings are necessary for a diagnosis and all three will only be present in half of cases. Rather, the clinician should be aware that in the presence of significant risk factors any of these symptoms should raise suspicion.

C. Risk factors include any comorbidities or clinical features that predispose to hypoperfusion of the colon. In particular, significant cardiovascular comorbidities such as coronary artery disease, congestive heart failure, diabetes, or a known history of vascular disease. Although colonic ischemia is largely due to reversible local hypoperfusion, or "non-occlusive" disease, emboli to the colonic vasculature are possible and patients with a history of atrial fibrillation or other arrhythmias should raise suspicion as well. Other, more specific elements of the history that should be elicited include a history of any abdominal surgery where the IMA may have been sacrificed (prior colonic resection; abdominal aortic aneurysm repair), irritable bowel syndrome, illicit drug use, or long distance running, as all have been shown to be risk factors. In patients in whom colonic ischemia is high on the differential diagnosis who present with peritonitis and/or hemodynamic instability unresponsive to resuscitative efforts, operative exploration should be pursued as this is worrisome for full-thickness, irreversible ischemia. If left unaddressed, this would lead to sepsis, shock, and ultimately death.

D. Although the diagnosis of colonic ischemia can often be made with a thorough history and physical exam alone, adjunctive investigations can help better localize the disease and predict the severity of the ischemic insult. Many prospective and retrospective studies have sought to identify laboratory markers to aid in diagnosis. Routine laboratory investigations should

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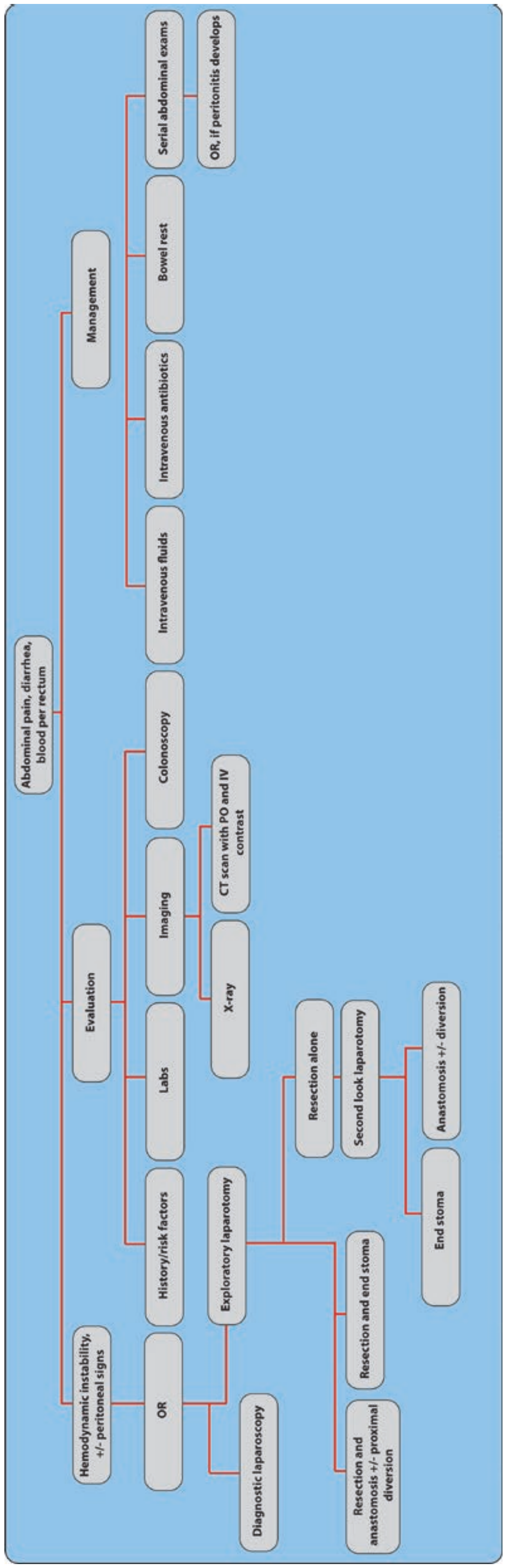

Fig. 57.1 Algorithm for ischemic colitis

include a CBC, BMP, LDH and lactate. Elevated BUN and LDH are the markers with the greatest specificity for colonic ischemia but many studies have found elevated WBC, decreased bicarbonate levels, and increased creatinine as surrogates for acid/base and volume status. Perhaps more important than the absolute values are their trends as treatment is initiated. Laboratory abnormalities should start to normalize with resuscitation; any worsening acidosis or leukocytosis are worrisome for progression of ischemia.

E. Imaging should begin with a plain radiograph of the abdomen. Although the findings will often be non-diagnostic, X-rays are quick and inexpensive. Furthermore, more ominous findings such as free air, portal venous gas, or pneumatosis can be seen on plain films and suggest severe, full thickness ischemia and the need for urgent surgical intervention. Although similarly non-specific, the classic sign of "thumbprinting" can be seen on plain films and suggests bowel wall edema and thickening. More often than not, however, plain X-rays will be inconclusive and the next step should be a CT scan with intravenous and oral contrast.

F. A CT scan serves four main purposes: (a) supporting the diagnosis of colonic ischemia with findings of fat stranding, bowel wall edema or findings of severe ischemia such as portal venous gas, pneumatosis, or free air, (b) rule out other pathology whose symptoms can overlap with colonic ischemia such as diverticulitis, infectious colitides, or inflammatory bowel disease (c) localize the segment of colon involved and any potential small bowel involvement, and (d) evaluate the mesenteric vasculature for atherosclerosis, stenosis, or occlusion. Given that most colonic ischemia is due to a transient, low-flow state, the major arteries will usually be patent, however clues such as stenosis or atherosclerosis can help identify a patient that may be at risk for ischemia.

G. Recent studies have shown that isolated right sided colonic ischemia may represent a specific entity with a different clinical course than other sites of colonic ischemia. Montoro and Brandt compared patients with colonoscopically or surgically confirmed isolated right colon ischemia to patients with other distributions of ischemia. Patients with ischemia of the right colon were generally sicker with increased comorbidities at baseline and had worse outcomes with a higher rate of operative intervention and higher eventual morbidity and mortality. Many authors have hypothesized that this is because right-sided ischemia is a manifestation of acute mesenteric ischemia given that the right colon is supplied by the SMA.

H. Although CT scan may offer significant information, colonoscopy remains the gold standard for diagnosis. Findings can represent a spectrum of mild disease including hemorrhagic nodules, edema, erythema, and friability, to manifestations of severe ischemia, including ulcerations and gangrene. Findings will vary depending not only on the severity but also on the timing of colonoscopy relative to time of initial insult. It is recommended that colonoscopy be performed within 48 h of presentation and that the colonoscope only be inserted to the distal most extent of the ischemic changes for fear of perforation from manipulation and insufflation of an ischemic segment of colon. A "single stripe sign," a single longitudinal ulcerated or inflamed colon strip, is considered diagnostic of colonic ischemia but is rarely seen on colonoscopy. Pathognomonic biopsy findings include mucosal infarction and ghost cells, however these are seen in less than 10% of overall cases and ghost cells are only seen 20% of cases requiring surgery.

I. Management of colonic ischemia includes bowel rest, aggressive intravenous fluid resuscitation, antibiotic administration, and serial abdominal exams. Given that the pathophysiology of colonic ischemia is relative hypoperfusion, optimization of intravascular volume status is crucial. While there is little evidence supporting the use of antibiotics in the literature, the loss of the mucosal barrier is believed to put patients at risk for bacterial

translocation. Antibiotics should be directed at gram negative and anaerobic pathogens and should continue for at least 7 days from diagnosis.

J. Patients who present with or develop signs of peritonitis or hemodynamic instability should be operatively explored. The specific approach is surgeon and patient dependent. If the diagnosis of colonic ischemia is in doubt, it may be useful to perform a diagnostic laparoscopy to evaluate the colon and small bowel. However, in a patient who is hemodynamically unstable, laparotomy with the goal of quickly identifying and resecting the segment at risk is more prudent.

K. Any segment of colon with signs of irreversible ischemia should be resected. Areas of the colon that appear questionable but have not progressed to full thickness ischemia may be left behind with the intention of performing a second look laparotomy after aggressive resuscitation in the intensive care unit. Ultimately, all diseased segments of colon should be resected so that the patient is left with only healthy, well-perfused colon.

L. The decision to perform a bowel anastomosis (with or without proximal diversion) or an end colostomy/ileostomy depends largely on the patient's underlying comorbidities and current hemodynamic state. The surgeon must weigh the risks of performing an anastomosis versus the risks of a stoma. As many patients with colonic ischemia are elderly with comorbidities that put them at high risk for elective surgery, there is a high likelihood of permanent stoma in this patient population.

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Colonic Conditions: Infectious Colitis

58

William C. Cirocco and Shandra R. Day

See Algorithm in Fig. 58.1

A. Acute diarrhea is typically categorized as symptoms lasting <14 days while chronic diarrhea continues >30 days. Acute inflammatory colitis includes organisms such as *Campylobacter*, *Salmonella*, *Shigella*, Enterohemorrhagic and Enteroinvasive *E. coli* (EHEC and EIEC) and *E. histolytica* as well as *Clostridium difficile*. Several other infectious agents may cause chronic colitis such as other strains of *E. coli* (Enteropathogenic—EPEC, Enteroaggregative—EAEC), mycosis, mycobacterium (TB) and parasitic infections. Patients with chronic infection usually present with symptoms for weeks or months including fever, abdominal pain, weight loss, diarrhea and malabsorption. See Table 58.1 for a list of common causes of infectious colitis and Table 58.2 for treatment of specific causes of infectious colitis.

B. Severe colitis is typically associated with dehydration, fever and weight loss and may present with hypotension and leukocytosis. An abdominal/pelvis CT scan may show a thickened colon wall, colon dilation or exudative fluid. For *C. difficile* colitis, specific severity scoring systems have been described to categorize mild-to-moderate, severe and complicated disease (see Table 58.3).

C. Recurrent infectious colitis is frequently seen in patients with *Clostridium difficile* infection (CDI) and is typically categorized as recurrent CDI within 8 weeks of completion of therapy (see Table 58.4). Other infections known to cause recurrent disease include *Salmonella* (typically recurrent bacteremia or a chronic carrier state), *Cryptosporidium*, *Cystoisospora* and *Cyclospora* primarily in immunocompromised patients. In patients with recurrent symptoms, consider repeat infection or alternative pathogens based on risk factors and exposure.

D. Diarrhea is due to increased water content in stool caused by either decreased water absorption in the small bowel or active secretion of water throughout the bowel (through toxin production, invasion or tissue penetration). Diarrhea is typically defined as three or more loose or watery bowel movements within 24 h.

E. Fever and tenesmus suggest an inflammatory proctocolitis that may be caused by *Campylobacter*, *Shigella*, *E. histolytica*, *C. trachomatis* and *N. gonorrhea* as well as other opportunistic pathogens in HIV-infected patients. Symptoms lasting

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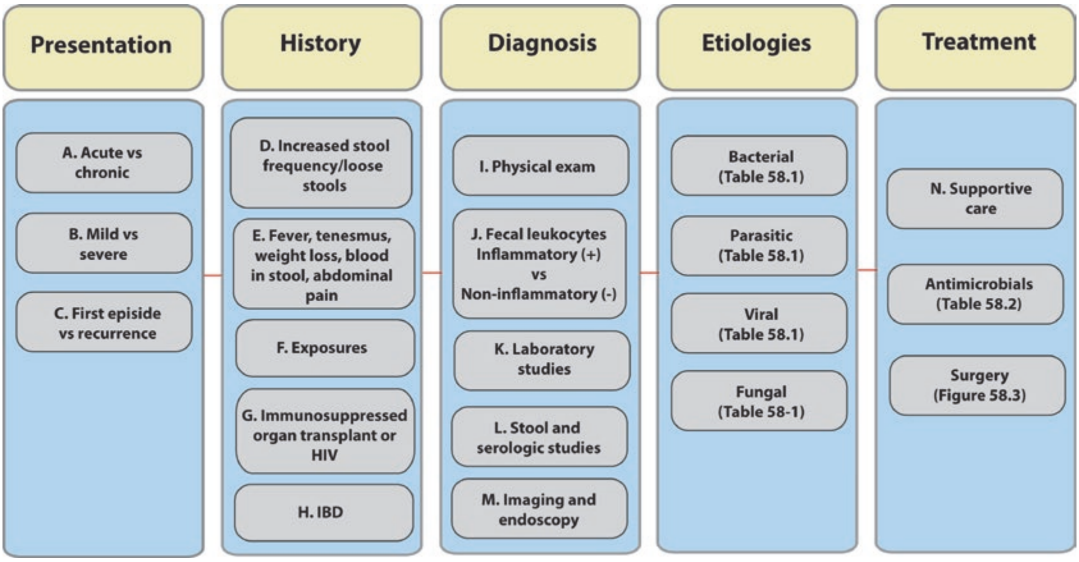

Fig. 58.1 Algorithm for evaluation of patients with diarrhea/colitis

Table 58.1 Common causes of infectious diarrhea/colitis

Bacterial	Parasitic	Viral	Fungal
Shigella	*E. histolytica*	CMV	*Histoplasmosis*
Salmonella	*Strongyloides*	HSV	*Candida*
Campylobacter	*Giardia*[a]	Norwalk virus[a]	
EHEC/EIEC	*Cryptosporidium*[a]	Rotavirus[a]	
C. difficile (see Fig. 58.2)	*Cystoisospora belli*[a]	Ebola	
Yersinia enterocolitica	*Cyclospora*[a]		
Vibrio spp.[b]	Microsporidia[a]		
TB	Schistosomiasis		
Aeromonas	Chagas		
Traveler's Diarrhea[a]			
EPEC/EAEC[a]			
C. trachomatis (proctocolitis)			
N. gonorrhea (proctocolitis)			

[a]These pathogens are a common cause of infectious diarrhea but do not typically cause inflammation
[b]*Vibrio cholera* does not invade the cell wall and there are few neutrophils in the stool. Diarrhea is caused by enterotoxin that causes watery diarrhea. Other species of *Vibrio* such as *Vibrio parahaemolyticus* cause diarrhea through both enterotoxin production as well as small bowel inflammation

>10 days with associated weight loss should raise concern for *Giardia*, *Cyclospora* or *Cryptosporidium*. Bloody diarrhea (especially in the absence of fecal leukocytes) suggests infection with EHEC or *E. histolytica* (leukocytes are destroyed by the parasite). Consider *Yersinia enterocolitica* if there is unexplained abdominal pain and fever or appendicitis-like symptoms.

F. Risk factors for CDI include both the number of hospitalizations and prolonged duration of hospitalization (>50% of patients had CDI with hospitalization >4 weeks) along with the use of antibiotics and proton pump inhibitors. Patients should be questioned regarding travel, especially travel outside of the USA to tropical areas where there is increased risk for traveler's diarrhea as well as viral and parasitic pathogens. It is also important to investigate for illness in family members and other close contacts. Patients with a history of anoreceptive sex may develop proctitis

Table 58.2 Antimicrobial treatment for common causes of infectious diarrhea/colitis

Pathogen	Treatment
Shigella	Ciprofloxacin 500 mg PO BID or Levofloxacin 500 mg PO daily or Azithromycin 500 mg PO Daily × 3 days
Salmonella	Mild illness—none, Possible bacteremia—Ciprofloxacin 500 mg PO BID (Ceftriaxone 2 g IV Q24 h if Cipro resistant) × 5–7 days
Campylobacter	Mild illness—none, severe or immunocompromised—Azithromycin 500 mg PO daily or Ciprofloxacin 750 mg BID PO × 3 days if uncomplicated, 7–14 days if complicated
Yersinia	Ciprofloxacin 500 mg PO BID or TMP/SMX PO × 5 days
Vibrio	Doxycycline 300 mg PO × 1 dose or Ciprofloxacin 1 g PO × 1 dose or Azithromycin 1 g PO × 1 dose
Aeromonas	Mild illness—none, severe diarrhea or immunocompromised—Ciprofloxacin, Ceftriaxone or TMP/SMX
EHEC	None
TB	Typical TB treatment
C. difficile	See Fig. 58.2
Giardia	Metronidazole 250 mg PO TID × 5–7 days
E. histolytica	Metronidazole 750 mg TID PO × 5–7 days followed by a luminal agent Paromomycin 30 mg/kg/day PO in three divided doses × 5–10 days or Diloxanide PO 500 mg TID × 10 days
Schistosomiasis	Praziquantel 20 mg/kg PO TID × 1 day
Strongyloidiasis	Ivermectin 200 μg/kg daily × 2 days, Albendazole 400 mg PO BID × 10–14 days
Cryptosporidium	Supportive care, reduce immunosuppression, +/-Nitazoxanide 500 to 1000 mg PO BID (×14 days)
Cystoisospora belli	TMP/SMX 1 tablet PO BID × 10 days followed by chronic suppression until immune system recovers
Cyclospora	TMP/SMX 1 tablet PO BID × 7–10 days followed by chronic suppression until immune system recovers
CMV	Ganciclovir, Valganciclovir (dose adjusted based on renal function)
HSV	Acyclovir, Valacyclovir (dose adjusted based on renal function)
Norwalk virus, Rotavirus, Ebola	None
Histoplasmosis	Amphotericin B (dose dependent on formulation used), Itraconazole 200 mg PO TID × 3 days followed by 200 mg PO BID

TMP/SMX trimethoprim/sulfamethoxazole

Table 58.3 Special populations of patients with infectious colitis

Risk factor	Details
HIV/AIDS	Greatest risk for OIs when CD4 count is less than 200
Solid organ transplant	Immunosuppressed
Bone marrow transplant	Immunosuppressed
IBD (Crohn's/ulcerative colitis)	Immunosuppressed or altered immunity
Chronic steroid use	Immunosuppressed
Underlying malignancy	Altered immunity (including leukemia and lymphoma)
Recent chemotherapy	Immunosuppressed

Table 58.4 *C. difficile* infection severity scoring system (adapted from Suarwicz et al.)

Severity	Criteria
Mild-to-moderate disease	Diarrhea, not meeting criteria for Severe or complicated disease
Severe disease	Serum albumin <3 g/dl plus one of the following: – WBC ≥15,000 cells/mm^3 – Abdominal tenderness
Severe and complicated disease	Any of the following (due to CDI): – ICU admission – Hypotension (with or without vasopressor use) – Fever ≥38.5 °C – Ileus or significant abdominal distention – Mental status changes – WBC ≥35,000 or <2,000 cells/mm^3 – Serum lactate >2.2 mmol/l – End organ failure (mechanical ventilation, renal failure, etc.)

secondary to multiple sexually transmitted infections (HSV, Gonorrhea, Chlamydia, Syphilis) or colitis due to enteric pathogens (*Campylobacter*, *Shigella*, *C. difficile*, *Chlamydia*) with the location determined at colonoscopy. Of note, these patients are also at risk for *Giardia* which causes a non-inflammatory diarrhea.

G. Immunosuppressed patients, including those with a history of organ and stem cell transplant as well as HIV/AIDS are at increased risk for multiple bacterial, viral and parasitic infections. These patients may also have more than one pathogen, therefore continued monitoring of their symptoms and continued work-up is appropriate. One pathogen to note, Norovirus, typically causes a self-limited gastroenteritis but in immunocompromised patients may lead to chronic infection and severe complications.

H. Patients with inflammatory bowel disease (IBD) may have colitis due to their underlying disease, but they are also at risk for other infections including CDI as they are frequently on immunosuppression for their IBD, thus increasing their risk for opportunistic infection (OI).

I. Initial evaluation should be done for signs of systemic toxicity including hypotension, lethargy and altered mental status or dehydration with postural hypotension, tachycardia and dry mucous membranes. Abdominal examination should evaluate for the presence of bowel sounds, abdominal distention or peritoneal signs (rebound, guarding, rigidity).

J. Non-inflammatory diarrhea suggests one of the following infectious organisms: *Giardia*, *Cryptosporidium*, *Vibrio*, *E. coli* (not EIEC or EHEC), *Staphylococcus aureus*, *Bacillus cereus*, or *Norwalk virus*. The presence of blood without fecal leukocytes is suggestive of EHEC or amebiasis. Inflammatory diarrhea suggests infection with *Shigella*, *Salmonella*, *Campylobacter jejuni*, EIEC or CDI.

K. Initial laboratory evaluation may include CBC with differential (bandemia, anemia, thrombocytopenia, with profound leukocytosis suggests severe CDI), chemistry (electrolyte abnormalities and creatinine for renal function), liver function tests and serum lactate.

L. Initial work-up depending on symptoms and exposures may include stool culture or stool enteric PCR for *Salmonella*, *Campylobacter*, *Shigella*/EIEC, Shiga toxin, parasite testing for *Giardia*, *E. histolytica* and *Cryptosporidium* and *C. difficile* toxin titers (see Algorithm #2). Consider stool studies for fecal lactoferrin, comprehensive ova and parasites and special studies for *Cryptosporidium*, *Cystoisospora*, *Cyclospora* and *Microsporidia*. *Yersinia enterocolitica*, *Vibrio* spp. and *Aeromonas* requires special culture media and can be specifically requested. Special stool studies are required to evaluate for viral pathogens including rotovirus and Norwalk virus. Serologic testing for *Strongyloides* and *E. histolytica* may be considered if there are any risk factors or peripheral eosinophilia (especially with *Strongyloides*).

M. Abdominal plain films may show colon dilation or toxic megacolon concerning for severe CDI (see Algorithm 2). An abdominal/pelvis CT scan may show colon wall thickening suggestive of active colitis but has limited sensitivity and specificity. Flexible endoscopy may be very helpful in evaluating causes of inflammatory colitis. Colonic ulcers are suggestive of amebiasis or Crohn's disease, but necrotic ulcers can also be seen in *Shigella*. The presence of pseudomembranes are diagnostic of CDI, but they are not always identified. Testing for *N. gonorrhoeae*, *C. trachomatis*, HSV and syphilis should be undertaken if localized proctitis is visualized, especially in patients with a history of anoreceptive intercourse. Biopsies of visible lesions of the colorectal mucosa may be very helpful in differentiating infectious colitis from IBD as well as identifying specific pathogens on staining including *cryptosporidium*, *E. histolytica*, CMV, HSV, TB and *Histoplasmosis*. Patients with known underlying IBD such as ulcerative colitis (UC) or Crohn's disease are challenging because they are at increased risk for infectious complications although biopsies will frequently show non-specific colitis so that it is very important to ask for special, pathogen specific staining.

N. Supportive care for patients with infectious colitis can range from IV fluid and electrolyte replacement in patients with dehydration to ICU care with mechanical ventilation and vasopressor support in patients with multiple organ system failure (see Algorithm 3). In patients with mild diarrhea/colitis, oral rehydration should be encouraged. Appropriate isolation and hand hygiene, especially in patients admitted to the hospital, should also be instituted depending on the pathogen. Contact isolation and hand washing with soap and water in patients with diarrhea due to CDI is critical to decrease the risk of nosocomial transmission. See Table 58.2 for specific antimicrobial therapies (if indicated) depending on the type of pathogen.

See Algorithm in Fig. 58.2

A. Presenting symptoms include the onset of diarrhea (>3 loose, frequent stools per day), fever, loss of appetite, nausea and abdominal pain with distension and/or abdominal cramping/bloating.
B. A change in vital signs may be absent entirely or only include fever early in the clinical course versus the other end of the spectrum with more fulminant infection leading to systemic sepsis and hemodynamic instability requiring vasopressor support (see Table 58.4).
C. Severe CDI frequently causes leukocytosis and WBC count >35,000 cells/mm^3 is associated with severe and complicated infection. Leukopenia with WBC count <2,000 cells/mm^3 may also be seen in severe and complicated disease. Patients with severe CDI should have additional laboratory evaluation including measurements of electrolytes and renal function (serum creatinine), albumin (<3 g/dl in severe disease) and lactate (>2.2 mmol/l in severe and complicated disease). The CDI severity scoring system is presented in Table 58.4.
D. Underlying illnesses including renal failure and malignancy places patients at increased risk for CDI. Immunosuppressed patients are at increased risk for severe infection including transplant recipients, patients receiving chemotherapy, and patients with HIV/AIDS. HIV/AIDS patients who require emergent subtotal colectomy have a dramatically increased mortality rate up to 100% in one series.
E. There is no established preferred test for the diagnosis of CDI as the diagnostic testing available varies based on the institution and lab. It is important that only stools from patients with diarrhea (not formed or semi-formed stool) be tested for *C. difficile* toxin.

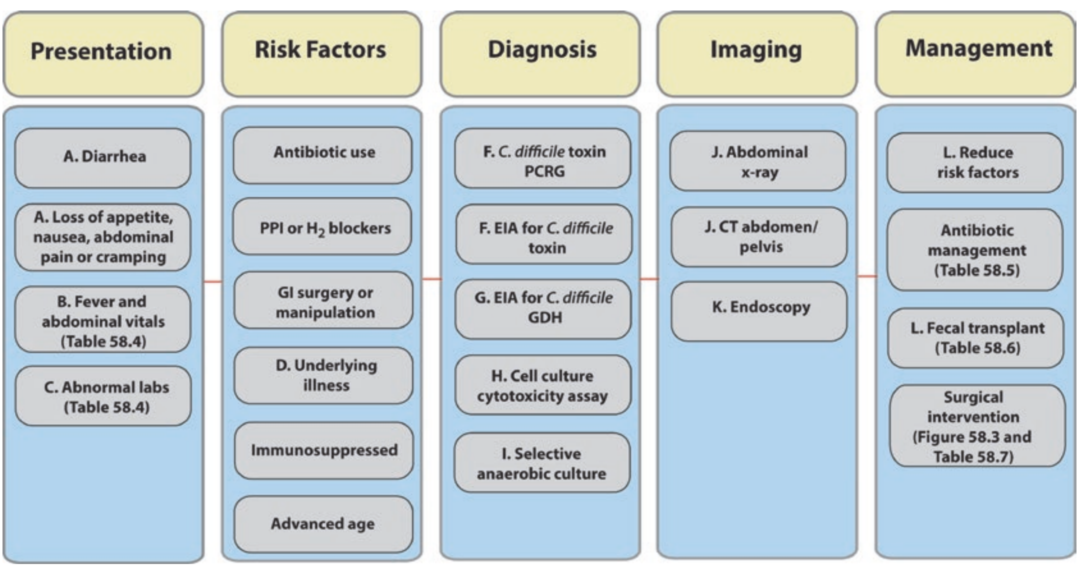

Fig. 58.2 Algorithm for evaluation and management of patients with *C. difficile* infection

F. The guidelines for the diagnosis, treatment and prevention of CDI from 2013 recommend the use of nucleic acid amplification tests for *C. difficile* toxin such as PCR for the diagnosis of CDI over toxin A + B Enzyme Immunoassay (EIA).
G. Glutamate dehydrogenase (GDH) EIA screening tests can be used as part of an algorithm with subsequent toxin A + B EIA testing.
H. Cell culture cytotoxicity assay is typically a send out test but may be helpful clinically in patients with multiple potential causes of diarrhea and colitis, including patients with underlying IBD. A positive *C. difficile* cytotoxicity assay indicates that the diarrhea is due to CDI while a negative test suggests another etiology may be the primary cause of the diarrhea.
I. *C. difficile* culture alone is not sufficient to diagnose CDI since not all strains of *C. difficile* produce toxin.
J. Imaging studies such as abdominal plain films may show increased dilation of the colon. A CT scan of the abdomen may also reveal colon wall thickening, perhaps 'ascites' (more accurately, exudative fluid from the colon) or even perforation in later stages.
K. Flexible endoscopy may reveal the presence of pseudomembranes on direct visualization (the origin of the moniker 'pseudomembranous colitis', the original name attached to CDI). The presence of pseudomembranes is not always identified and is not required in order to establish a diagnosis of CDI. Biopsy will merely confirm the presence of colitis of a non-specific inflammatory origin. Underlying IBD (UC or Crohn's disease), will further complicate the work-up, establishment of a diagnosis and potential treatment. Patients on chronic immunosuppressive therapy (IBD, transplant, cancer patients or patients on chronic steroid therapy) may prove especially challenging.
L. Discontinuation of systemic antibiotics, if possible, is the cornerstone of the management of CDI. If antibiotics are required for management of a concurrent infection, a prolonged course of CDI treatment may be indicated. The use of any anti-peristaltic agents should be avoided because this may prolong CDI and perhaps even precipitate the development of toxic megacolon. Discontinuation of PPIs and H_2 Blockers, if possible, is especially important to reduce the risk of recurrent CDI.
M. Fecal microbiota transplant (FMT) should be considered for patients with ≥2 episodes of CDI who have failed maximal medical therapy which typically includes either a prolonged taper of oral vancomycin or rifampicin (Table 58.5). Indications, contraindications as well as preparation and post FMT management are presented in Table 58.6.

Table 58.5 Medical management of *C. difficile* infection

Clinical definition	Medical management
Initial episode, mild disease	Vancomycin 125 mg PO QID × 10–14 days or Fidaxomicin 200 mg PO BID × 10 days
Initial episode, moderate disease	Vancomycin 125 mg PO QID × 10–14 days or Fidaxomicin 200 mg PO BID × 10 days
Initial episode, severe disease	Vancomycin 500 mg PO four times daily plus Metronidazole 500 mg IV Q8 h or Fidaxomicin 200 mg PO BID × 10 days plus Metronidazole 500 mg IV Q8 h Consider surgery for patients with ileus
First recurrence	Vancomycin 125 mg PO × 10–14 days or Fidaxomicin 200 mg PO BID × 10 days for first recurrence
Second recurrence	Fidaxomicin 200 mg PO BID × 10 days or Vancomycin 125 mg PO tapered regimen (four times daily × 14 days, then BID × 7 days, then daily × 7 days, then every other day × 7 days, then every 3 days × 14 days, then stop) or consideration for fecal microbiota transplant (FMT) (Table 58.6)

Table 58.6 Fecal microbiota transplant (FMT) for the treatment of *C. difficile* Infection

Indications	≥2 episodes of recurrent CDI and failure of appropriate antibiotic therapy (includes either oral vancomycin taper or fidaxomicin)
Contraindications	Severe colitis, toxic megacolon and other complications that may be a contraindication to colonoscopy (e.g. perforation, megacolon). Caution is advised for patients who have immunosuppression or other comorbid conditions and patients who will require continued broad spectrum antibiotics
Recipient preparation	Prior to undergoing FMT, patients undergo a 2-day bowel preparation and any antibiotics are stopped 2 days before the procedure (including medications to treat *C. difficile*)
Technique	Fecal microbiota instilled at intervals via colonoscopy port during withdrawal starting in the cecum
Post-procedure care	Following FMT, no additional *C. difficile* antimicrobials are administered, also avoid any antimicrobials for as long as possible going forward (ideally at least a year)

See Algorithm in Fig. 58.3

A. Abdominal findings that are most concerning include signs of intra-abdominal catastrophe such as peritoneal 'signs': rebound tenderness, guarding and abdominal wall rigidity. Another significant finding is significant abdominal distention that may contribute to respiratory embarrassment and distress.
B. Respiratory distress could progress to respiratory failure and the need for mechanical ventilation and is a risk factor for in-hospital mortality.
C. Mental confusion and disorientation may be attributable to several factors including systemic sepsis and respiratory embarrassment leading to oxygen desaturation.
D. Altered vital signs across the board typically include: elevated temperature, oxygen desaturation, sinus tachycardia and hypotension. Significant hypotension requiring vasopressor agents is another risk factor for in-hospital mortality.
E. Low urine output may be attributed to: hypotension, low intra-vascular volume (dehydration) and abdominal compartment syndrome.
F. Marked leukocytosis in the 30–50,000 WBC range with significant bandemia often precedes the onset of hypotension and organ dysfunction. A retrospective review of 130 cases from Canada noted that patients with leukocytosis greater than or equal to 50,000 or lactate greater than or equal to 5.0 mol/l had a 30-day mortality rate of 75%. At the other end of the spectrum, systemic sepsis may also manifest as a markedly depressed WBC < 1,500. Systemic sepsis may lead to disseminated intravascular coagulation (DIC) with active fibrinolysis, consumption of coagulation factors and functional impairment of platelets resulting in a hypocoagulable state making hemostasis difficult to achieve if an operation becomes necessary. An increase in creatinine level precedes the development of renal insufficiency and perhaps renal failure. A combination of hypovolemia, hypotension and mechanical ventilation all contribute to acidosis which may manifest as a decreased pH and increased pCO_2 on ABGs, decreased serum CO_2 and increased serum lactic acid.
G. Bedside imaging is best for unstable ICU patients. Plain films may reveal colon dilation or free air if the colon has perforated. CT scans are the most sensitive indicator of CDI, but the use of IV contrast should be carefully considered because of underlying renal compromise from ongoing sepsis and the potential for renal insufficiency. When obtained, CT findings may include a thick colon wall, pericolic stranding and free exudative fluid (often mistakenly referred to as 'ascites'). CT scans predicted OR findings in

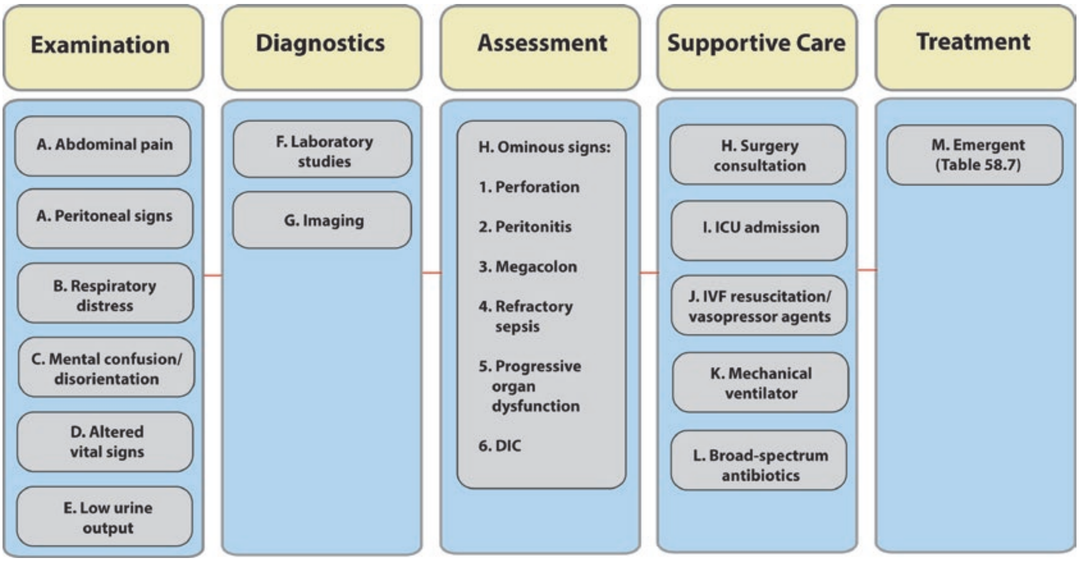

Fig. 58.3 Algorithm for ominous signs/indications for emergency surgery; DIC disseminated intravascular coagulation

94% of cases. In one retrospective series of 21 patients, CT findings were consistent with pancolitis 66% of the time, right-side only colitis in 19% and left side only colitis in 15% of patients. Rectal sparing occurs in up to 60–70% of patients.

H. A retrospective study at a single institution revealed that admission to a colorectal or general surgery service was independently associated with a statistically significant decrease of in-hospital mortality. If not already involved, surgical consultation is best requested early in the downward spiral of CDI, but the reality is that surgeons are often not involved until the late stages when an operation becomes necessary. A colorectal or general surgeon should be consulted immediately when any patient with CDI is transferred to the ICU.

I. Given the presence of the above ominous findings, ICU admission is mandated.

J. Intravenous fluid resuscitation is important to maintain renal function and for hemodynamic support. Intravenous vasopressor support is often required to maintain hemodynamic stability.

K. Mechanical ventilator support often becomes necessary as respiratory embarrassment from acute abdominal distension progresses to respiratory failure.

L. Broad spectrum intravenous antibiotics are appropriate as emergency surgery becomes necessary and concern for gut bacterial translocation in severe colitis or perforation.

M. The indications for emergent operation include: peritonitis, megacolon, refractory sepsis, progressive organ dysfunction and, rarely, perforation. Patients with malignancy, immunosuppression, renal insufficiency or patients on antiperistaltic agents are at increased risk for requiring surgical intervention. When the decision for emergency subtotal colectomy and end ileostomy becomes inevitable, a surgical checklist prepares the patient and is helpful to the surgeon (Table 58.7). Fulminant CDI carries a high postoperative mortality rate in the range of 32–100%. In a retrospective study of 14 patients, those patients with multiple organ failure had a mortality rate of 67% vs. 13.5% for patients without multiple organ failure. Total abdominal colectomy or subtotal colectomy has been labeled the 'operation of choice' or the gold standard of operations. Often, patients in septic shock will have a dramatic and perhaps even immediate normalization of their vital signs as the specimen is finally physically removed and handed off the OR table. The appearance of the colon

Table 58.7 Checklist for emergent surgery

✓	Category	Details
	Labs – CBC (Hgb, platelets) – PT/PTT – ABGs – Electrolytes (K^+, Na^+, Mg^+)	Depending on results of labs, transfusion of blood products may be required prior to OR or during operation
	Blood products – FFP – PRBC – Pooled platelets – Cryoprecipitate	Transfusion on a case by case basis, dependent on underlying health of the patient, including recent chemotherapeutics and development of DIC
	Invasive lines – CVC (swan) – Arterial line	
	Stoma site marking	Enterostomal therapist
	ICU bed	
	Vasopressor agents	Need for pressure support may decrease dramatically following removal of the specimen (colon)
	Antibiotic coverage	Perioperative antibiotics to cover a broad spectrum of organisms due to concern for gram negative sepsis and possible gut bacterial translocation

may be deceptively benign with full thickness ischemia rare and occurring very late in the course of the disease. If there are physical signs of colon ischemia or advanced CDI (either on gross examination in the OR or on endoscopic examination), it is typically more pronounced in the proximal colon with gradual physical improvement in a proximal-to-distal direction. In the OR, as the colon resection progresses in a proximal-to-distal direction, the end point of colectomy may be tailored to the rectosigmoid/distal sigmoid colon to remove confluent disease while perhaps leaving a viable distal sigmoid either as a mucous fistula or more simply a stapled Hartmann's pouch (subtotal colectomy). Therefore, if the patient should survive surgery and become a candidate for re-establishment of intestinal continuity, the functional result of an ileal-distal sigmoid anastomosis may theoretically be an improvement over the function of an ileorectal anastomosis. In general, the literature regarding non-resection operations for severe CDI, including ileostomy and cecostomy, reveals that patients have "fared poorly".

Acknowledgements *Disclosures*: None.

Suggested Reading

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59 Colonic Conditions: Benign Colonic Neoplasia

Taryn E. Hassinger and Charles M. Friel

Refer to Algorithm in Fig. 59.1

A. Benign colonic neoplasia can be divided into two primary categories, adenomatous polyps and serrated polyps. Adenomatous polyps comprise approximately two-thirds of all colonic polyps, making them the most common of the neoplastic polyps. They are categorized by their gross appearance into sessile, pedunculated, flat, or depressed lesions. Histologically, these lesions are further identified as tubular, villous, or tubulovillous adenomas. Serrated polyps are the second most common subtype of benign colonic neoplasia. This group includes a heterogeneous group of lesions including hyperplastic polyps, traditional serrated adenomas (TSA), and sessile serrated polyps/adenomas (SSA/P). Other less common types of benign colonic neoplasia include hamartomatous polyps.

B. Regardless of the type of neoplastic lesion, they are most often discovered incidentally on screening endoscopy, thus typically in patients over 50 years of age. Small lesions are unlikely to cause bleeding, but larger more advanced polyps can cause chronic, slow bleeding and thus result in positive fecal occult blood testing and anemia. Less commonly, a large lesion can cause obstructive symptoms, a presentation more often seen with adenomatous polyps.

C. Once a polyp is discovered, a complete colonoscopy should be performed to inspect for synchronous polyps and/or cancers if the original endoscopic procedure did not completely clear the colon.

D. Adenomatous polyps are the most common type of benign colonic neoplasia. They are more common in men, and risk factors also include older age and obesity. These lesions are grossly categorized as sessile, pedunculated, flat, or depressed. Sessile polyps have their bases attached to the colon wall, and pedunculated lesions have a mucosal stalk connecting the polyp to the colon wall. Flat polyps have a height less than half the lesion's diameter, and depressed polyps have an excavated appearance. Histologically, adenomas are further categorized by their glandular architecture. Tubular adenomas are the most predominant, representing over 80% of colonic adenomas. They are composed of a network of branching epithelium. An adenoma's structure must be at least 75% tubular in order to be classified as a tubular adenoma. Villous adenomas comprise 5–15% of adenomas and contain long, straight glands from the surface epithelium to the center of the polyp. To be considered a villous polyp, the

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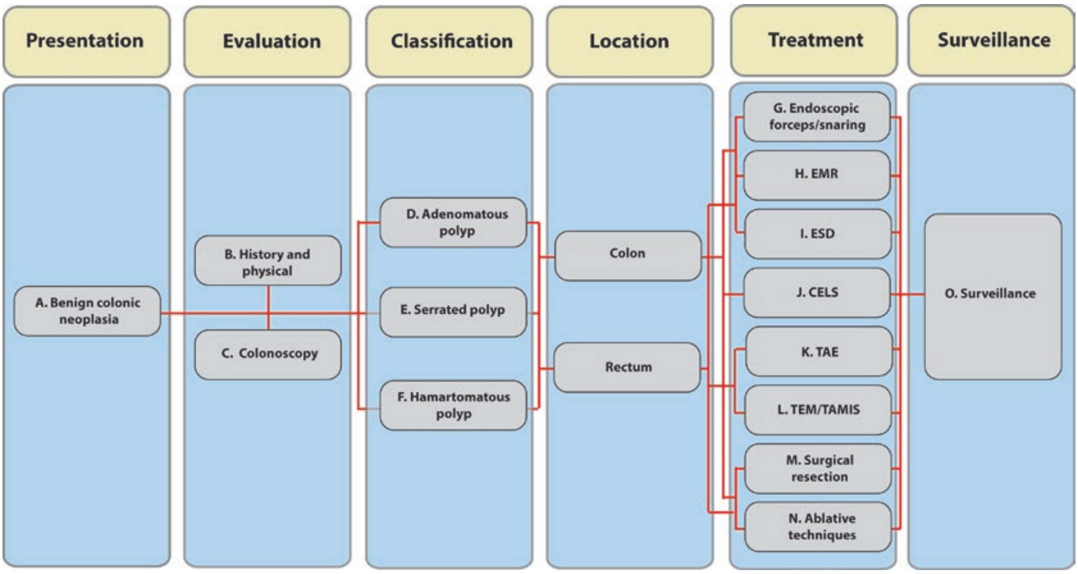

Fig. 59.1 Algorithm for benign colonic neoplasia. *EMR* endoscopic mucosal resection, *ESD* endoscopic submucosal dissection, *CELS* combined endoscopic laparoscopic surgery, *TAE* transanal excision, *TEM* transanal endoscopic microsurgery, *TAMIS* transanal minimally invasive surgery

lesion must contain at least 75% villous components. Finally, tubulovillous adenomas account for 5–15% of colonic adenomas. To be classified as tubulovillous, an adenoma must contain 26–75% villous components. In all adenomas, the area of proliferation is mainly located in the upper part of the crypt.

Adenomatous polyps are dysplastic lesions, and they are described as having high-grade or low-grade dysplasia. The degree of dysplasia impacts the risk of colorectal cancer progression, with high-grade dysplasia imparting a higher risk. Villous adenomas and polyps over 1 cm in diameter are at increased risk of harboring high-grade dysplasia or progressing to colorectal cancer. Additionally, villous histology, presence of high-grade dysplasia, and larger numbers of polyps impart an increased risk for development of metachronous colorectal cancer. Due to their obligatory presence of dysplasia, adenomatous polyps should be removed endoscopically. If unable to resect endoscopically, surgical resection should be considered. The ongoing risk of future polyp development and metachronous colorectal cancer mandates that these patients continue to undergo surveillance colonoscopy.

E. Histologically, serrated polyps are characterized by glandular serration with a luminal saw-toothed pattern in epithelial crypts. Hyperplastic polyps are the most common subtype, comprising over 75% of serrated polyps. These are typically flat, pale lesions located at the end of rectosigmoid mucosal folds with the proliferation zone located near the bottom of the crypts. They are commonly less than 5 mm in diameter and do not contain dysplasia. While they develop at a younger age than adenomas, hyperplastic polyps do not substantially increase in frequency with age. It is rare for small (≤1 cm), distally located hyperplastic polyps to develop into colorectal cancer. Alternatively, large hyperplastic polyps are considered to be precursor lesions to SSPs, and as such can progress to cancer. Given this, patients with small, distal hyperplastic polyps should follow normal colorectal screening guidelines.

Sessile serrated polyps are the newest identified members of the serrated group, representing 15–20% of these polyps. These lesions are flat or mildly elevated, greater than 5 mm in diameter, and most commonly found in the proximal colon. Dysplasia is also typically absent, but the proliferation

causes asymmetry of the crypts with some inverted crypts found below the muscularis mucosae (pseudo-invasion).

Traditional serrated adenomas are the least common of the serrated polyps, comprising just 5% of the group. They do, however, have a slightly higher prevalence in Asia. These lesions are usually located in the left colon and are more common in the elderly. They are exophytic lesions, histologically characterized by prominent serration and ectopic crypt formation with a loss of crypt orientation toward the muscularis mucosae. Unlike the other serrated polyps, TSAs do contain dysplasia.

Both SSPs and TSAs carry an increased risk of malignant degeneration and should be managed similarly to adenomatous polyps. The molecular pathway leading to cancer from a SSP differs from the chromosomal instability pathway associated with an adenomatous polyp. These cancers are usually associated with hypermethylation of the promoter region of MLH1. This epigenetic phenomenon results in underexpression of MLH1, resulting in tumors that are microsatellite unstable, CpG island methylator phenotype (CIMP)-high, and predominantly right-sided. Sessile serrated polyps can be very difficult to detect and can easily be missed during a colonoscopy. This may account, in part, for the observation that tumors detected following a reportedly normal colonoscopy are more likely to be microsatellite unstable and CIMP-high.

The flat nature of these polyps can also cause difficulty with complete endoscopic removal, and surgical resection can be a potential option in these cases. In addition, patients with distal serrated polyps appear to be at increased risk of synchronous and metachronous adenomas or colorectal cancer, predicating the need for continued endoscopic surveillance.

F. Hamartomatous polyps are rare, but are the most common polyps diagnosed in children. These polyps are also more commonly symptomatic, presenting with rectal bleeding, abdominal pain, obstruction, or anemia. They are typically cherry-red and pedunculated, varying in size. Histologically, hamartomatous polyps are divided into juvenile polyps and Peutz-Jeghers polyps.

Juvenile polyps are composed of normal epithelium with a dense stroma, inflammatory infiltrate, and dilated mucus-filled cystic glands. As implied by in the name, these polyps are the most common gastrointestinal polyps in children, though they can be diagnosed at any age. Juvenile polyps are typically located in the rectosigmoid region and are removed endoscopically when found due to bleeding risk. These polyps may be associated with adenomas and colorectal cancer, but this event appears quite rare. If there are multiple (i.e., juvenile polyposis syndrome), genetic testing may be required. If they are symptomatic and are not amenable to endoscopic removal, surgery may be required.

Peutz-Jeghers polyps are multilobulated with a papillary surface and branching bands of hyperplastic glandular mucosa overlying smooth muscle contiguous with the muscularis mucosae. They are usually, but not always, associated with Peutz-Jeghers syndrome and are most often found in people over the age of 40. Solitary Peutz-Jeghers polyps can harbor dysplasia and have been known to result in colorectal cancer. Given their association with Peutz-Jeghers syndrome, polypectomy plus colonoscopy and endoscopy is recommended.

G. There are numerous treatment modalities available for benign colonic neoplasia, varying based on the size and location of the lesion. The ultimate goals are to completely remove the neoplastic tissue and to provide an adequate tissue sample for pathological review. Most colonic polyps detected on colonoscopy are less than 10 mm in diameter. These small lesions have a low risk of dysplasia, and therefore resection techniques must be low risk. Polypectomy utilizing cold forceps is appropriate for lesions less than 3 mm in diameter. The lesion will often be removed with one bite, but a second pass can

be utilized. Risks of this procedure are quite low. Utilization of hot forceps is no longer recommended, especially in the right colon, given the increased risk of bleeding and perforation with this technique. Cold snaring is the preferred technique for lesions up to 7 mm in size (Fig. 59.2). The resection should include a small margin of normal tissue to ensure complete removal of the polyp. Hot snaring can be used for polyps over 7 mm in diameter. Pedunculated lesions are also appropriate for hot snaring given the increased risk of bleeding.

H. Endoscopic mucosal resection (EMR) is used to remove larger (1.5–2 cm), sessile polyps (Fig. 59.3). This technique is frequently

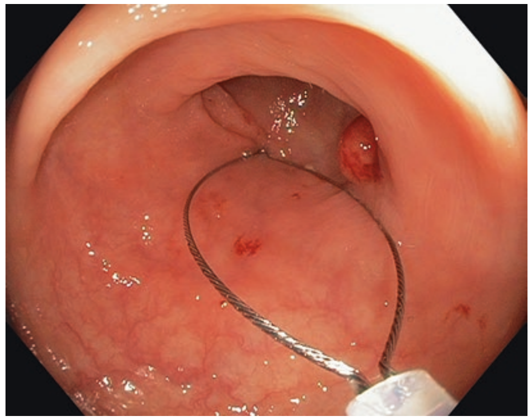

Fig. 59.2 Small sessile polyp amenable to cold snare polypectomy. (*Image provided by Charles M. Friel, MD, University of Virginia*)

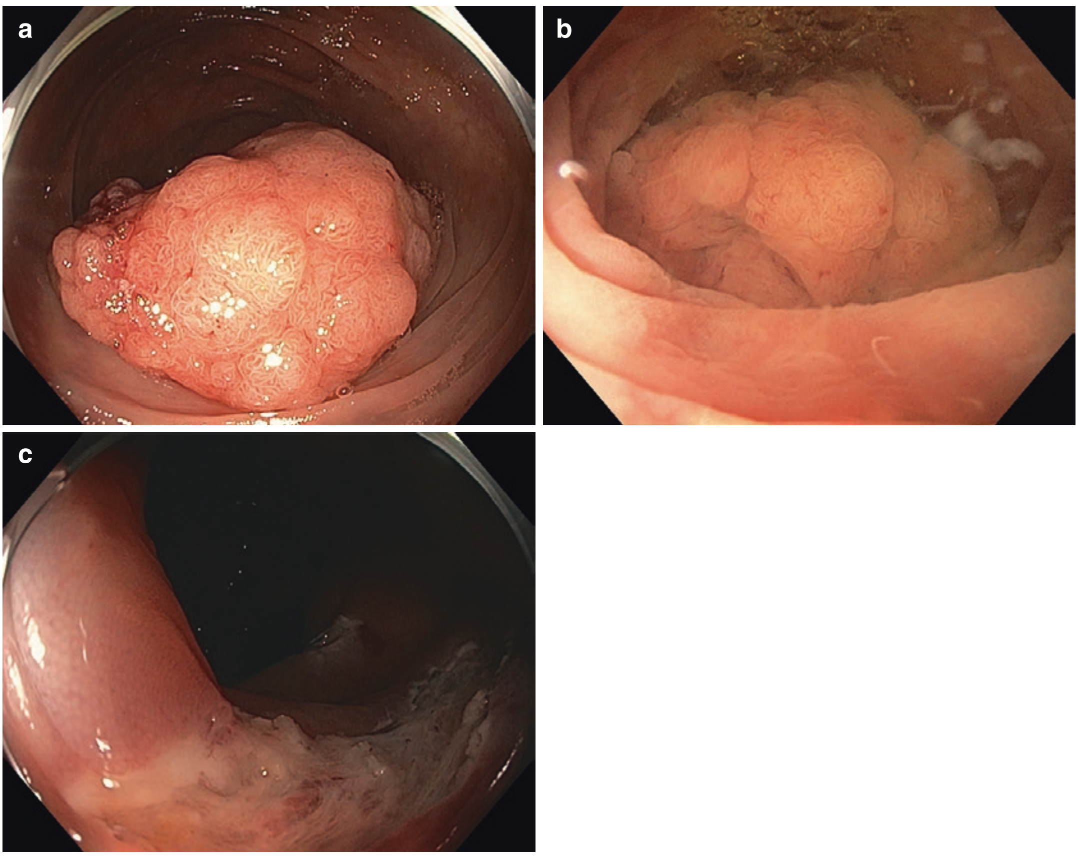

Fig. 59.3 Endoscopic mucosal resection (EMR) of a large ascending colon polyp. (**a**) Large ascending colon polyp. (**b**) Piecemeal EMR using snare cautery. (**c**) Final result showing complete resection. Tattoo placed for subsequent surveillance. (*These images were provided courtesy of Andrew Y. Wang, MD, Division of Gastroenterology and Hepatology, University of Virginia Health System*)

facilitated with submucosal injection of saline to lift the mucosal or submucosal lesion off of the muscularis propria. Because of the larger size, these lesions are typically then removed in a piecemeal fashion using electrocautery. Notably, piecemeal resection does make it more difficult for histologic evaluation, which is a concern for lesions found to have malignant foci.

I. Endoscopic submucosal dissection (ESD) is a more technically demanding variant of EMR (Fig. 59.4). This technique requires specialized training and involves submucosal injection with circumferential dissection of the involved mucosa and submucosa with diathermic knives. The goal is to accomplish an en bloc resection rather than a piecemeal resection. As such, this technique is mainly utilized for lesions felt to have a higher risk of harboring a malignancy. Additionally, submucosal tattooing should be considered when removing large polyps to allow for identification during follow-up colonoscopy or surgery (Fig. 59.5).

J. Combined endoscopic and laparoscopic surgery (CELS) is a newer alternative to segmental colonic resection for patients with an endoscopically unresectable polyp proximal to the rectum. This technique allows a laparoscopic surgeon to manipulate the bowel wall to allow for easier endoscopic polypectomy. Patients with a benign colonoscopic

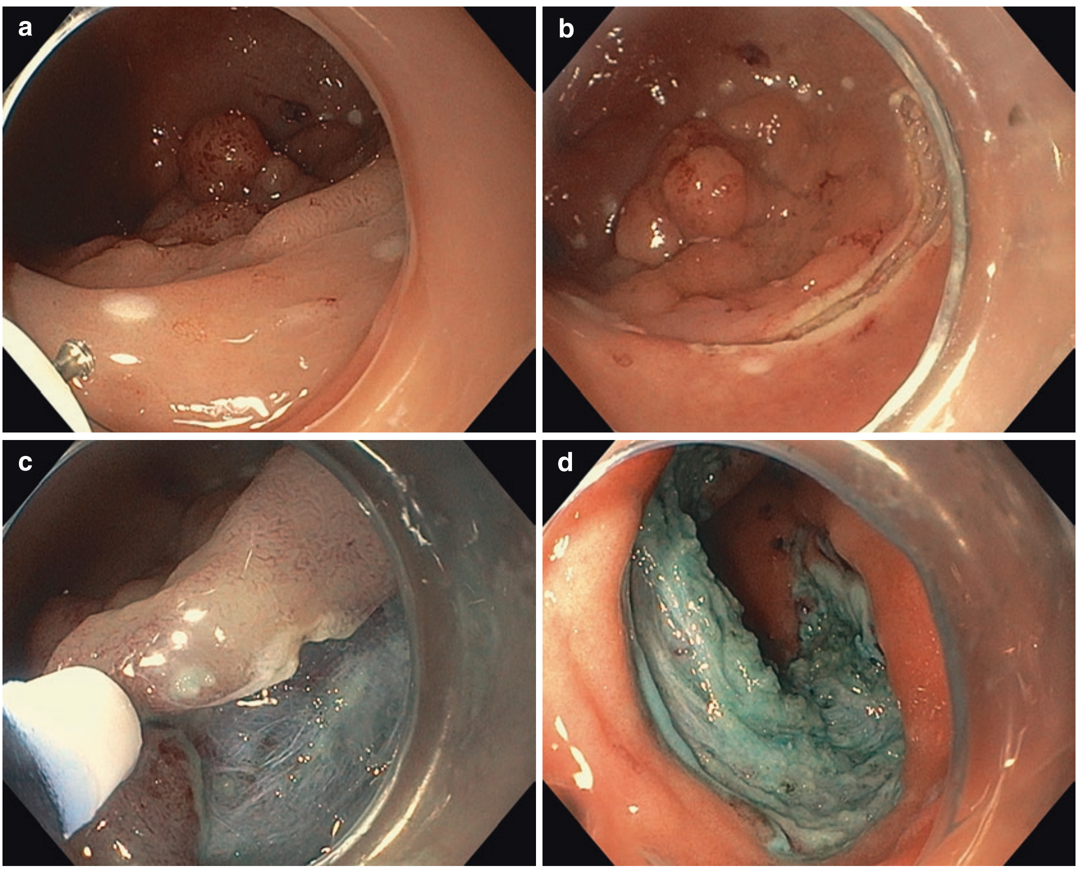

Fig. 59.4 Endoscopic submucosal dissection (ESD) of a large sessile polyp. (**a**) Circumferential markings were placed at least 5 mm from the edge of the polyp, and the polyp was lifted using a solution of 6% Hetastarch tinted with methylene blue. (**b**) Circumferential incision (**c**) followed by submucosal dissection performed using ESD knives and specialized electrosurgical generator. (**d**) Final result with tattoo markings. (*Images provided courtesy of Andrew Y. Wang, MD, Division of Gastroenterology and Hepatology, University of Virginia Health System*)

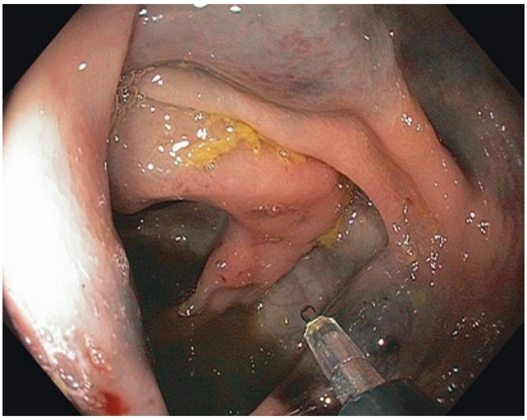

Fig. 59.5 Endoscopic tattooing of a colonic lesion. (*Image provided by Charles M. Friel, MD, University of Virginia*)

biopsy or a biopsy with high-grade dysplasia and benign appearance on endoscopy are eligible. Due to the necessary bowel manipulation, this technique is most useful in patients without an extensive abdominal surgical history. The patient is placed in modified lithotomy position, and carbon dioxide colonoscopy is performed to prevent the over-dilation of the colon. The endoscopist injects submucosal dilute indigo carmine solution to lift the polyp and help prevent a full-thickness injury. Endoscopic piecemeal resection is then performed. The laparoscopic surgeon can help manipulate the bowel to optimize the resection. Furthermore, the surgeon can visualize the bowel and place sutures if there is concern for a full thickness burn or perforation. An additional benefit of CELS includes the ability to immediately proceed to laparoscopic segmental resection if still unable to resect the polyp endoscopically or if visual findings are consistent with malignancy.

K. Large polyps in the distal rectum can be resected via transanal excision (TAE) with primary closure. This can be done in the submucosal plane, or a full-thickness resection can be performed if there is a high suspicion for malignancy. Endoscopic ultrasound is often performed prior to this procedure to ensure there is no invasion into the submucosa.

L. Transanal endoscopic microsurgery (TEM) and transanal minimally invasive surgery (TAMIS) are minimally invasive techniques that can be used to resect rectal polyps up to 18 cm from the anal verge, which is higher than can be accessed with TAE. Specialized equipment is used to perform a submucosal or full-thickness resection with primary closure. The recurrence rate with these techniques is lower than with TAE and is thus typically preferred. For those lesions that are too large for minimally invasive techniques, a surgical resection may be necessary.

M. Finally, if the polyp cannot be resected by any of these endoscopic techniques, a surgical resection is necessary, assuming the patient is medically fit. This latter point is critical to understand. When proceeding to surgical resection the surgeon must balance the risk of surgery with the potential benefit, remembering that the primary goal of surgery is to prevent a future cancer. If the patient's life expectancy is limited by either patient age and/or medical conditions, it may be prudent not to proceed with surgical resection.

On the other hand, once there is a decision to proceed to surgery it should be noted that these high-risk polyps could harbor occult cancer in up to 20% of patients. Therefore, surgical resection should follow the principles of an oncologic resection—including a high ligation of the appropriate vessels—so that if an occult invasive lesion is discovered on pathological review, the proper operation has been performed (Fig. 59.6). This is particularly true in very large polyps or those with high-grade dysplasia noted on preoperative biopsies.

N. Ablative techniques can also be used for polyps not easily resected by endoscopic means. The polyp is destroyed using an energy device, most commonly with electrocautery or an argon plasma coagulator (APC). Ablative techniques are generally not as effective as resection but can be used in high-risk patients or following a piecemeal resection to ablate areas that may not have been fully resected (Fig. 59.7).

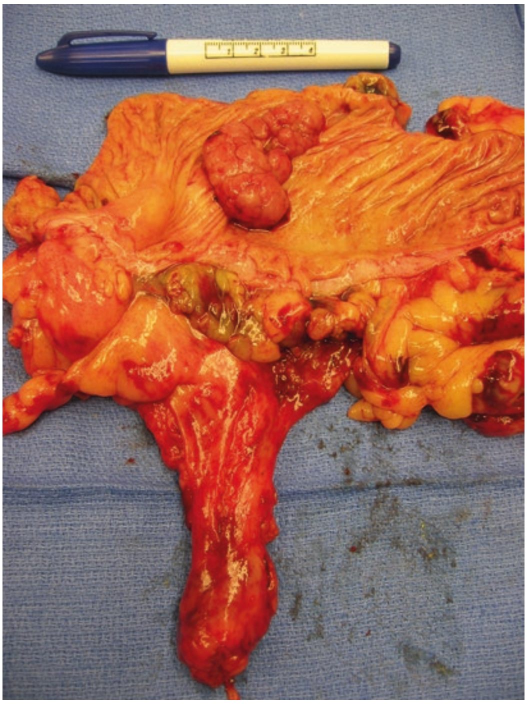

Fig. 59.6 Segmental resection of right colon demonstrating oncologic resection of cecal polyp with high ligation of the ileocolic vessel and appropriate surgical margins. (*Image provided by Charles M. Friel, MD, University of Virginia*)

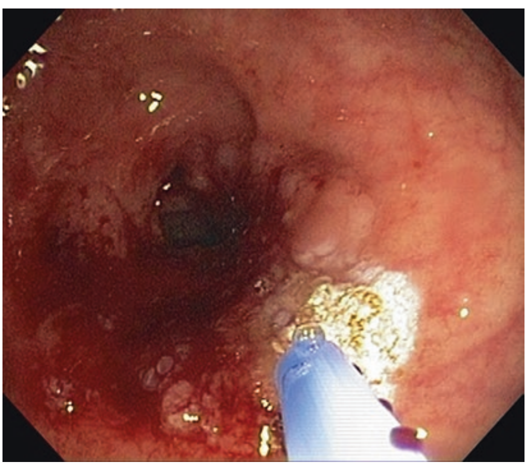

Fig. 59.7 Sessile polyp ablated using an argon plasma coagulator (APC). (*Image provided by Charles M. Friel, MD, University of Virginia*)

O. The timing and frequency of endoscopic surveillance varies based on pathology and colonoscopy findings. Recommendations are made based on risk of metachronous polyps and colorectal cancer (Table 59.1). Patients with no adenomas found on colonoscopy should undergo repeat colonoscopy in 10 years. For patients found to have 3–10 adenomas on baseline examination, repeat colonoscopy should be performed in 3 years. Those with over ten adenomas should have a repeat examination in less than 3 years. Patients found to have one or more tubular adenomas over 10 mm, any adenoma with villous features, or one or more adenoma with high-grade dysplasia results in a recommendation for repeat colonoscopy in 3 years. Recommendations for serrated polyps are more complicated with less supporting evidence in the literature. Patients with SSP(s) less than 10 mm and without dysplasia should undergo repeat exam in 5 years, while patients with SSP(s) 10 mm and larger, SSPs with dysplasia, or traditional TSA(s) should undergo repeat colonoscopy in 3 years. Polyps removed in a piecemeal fashion should have a repeat colonoscopy in 3–6 months to evaluate for recurrence. Endoscopic tattooing of these high-risk lesions at the time of resection is critical so that endoscopists can clearly identify to area of concern during follow-up exams. These

Table 59.1 US Multi-Society Task Force recommendations for colorectal cancer screening

Baseline colonoscopy findings	Surveillance interval (years)
No polyps	10
Small (<10 mm) hyperplastic rectosigmoid polyps	10
1–2 small (<10 mm) tubular adenomas	5–10
3–10 tubular adenomas	3
>10 adenomas	< 3
≥1 tubular adenomas ≥10 mm	3
≥1 villous adenomas	3
Adenoma with high-grade dysplasia	3
Sessile serrated polyp(s) <10 mm with no dysplasia	5
Sessile serrated polyp(s) ≥10 mm	3
Sessile serrated polyp with dysplasia	3
Traditional serrated adenoma	3
Serrated polyposis syndrome	1

recommendations all assume that the baseline colonoscopy was complete with adequate bowel prep and successful removal of all visible polyps.

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60 Familial Adenomatous Polyposis

Emily Steinhagen

Refer to Algorithm in Fig. 60.1

Familial adenomatous polyposis (FAP) is an autosomal-dominant syndrome characterized by more than 100 synchronous adenomatous polyps. Those with 10–99 adenomatous polyps are labelled as attenuated FAP (AFAP). The prevalence of FAP is estimated to be 1 in 6850 to 1 in 31,250. The incidence is equivalent in all races and geographic regions, and has an equal gender distribution. FAP has a variety of extracolonic manifestations and can be managed with a combination of surveillance and surgical interventions. An algorithm for management of FAP is found in Fig. 60.1.

A. Genetics

The etiology of FAP is a germline mutation in the *adenomatous polyposis coli* (APC) gene on the long arm of chromosome 17 that ultimately regulates cellular proliferation. It is inherited in an autosomal dominant fashion, though up to 30% of cases represent *de-novo* mutations in the gene. There is nearly 100% penetrance of the gene, meaning that nearly everyone with the mutation will manifest symptoms of FAP. A subset of patients with APC mutations have a less virulent variant, attenuated FAP (AFAP), which may have varied penetrance and delayed onset of colorectal cancer. There is also a subset of patients who do not have a detectable mutation but clearly have the phenotype. Those patients should be evaluated for *MYH*-associated polyposis and other syndromes but treatment should be guided by their phenotype if no genetic mutation is identified.

To some extent, there is some correlation between the location of the mutation on the gene and phenotype. This allows some prediction regarding polyposis, desmoid risk, and likelihood of other extracolonic manifestation. However, this correlation is not perfect as there are differences in phenotype amongst individuals who have the same mutation, which are likely due to the effect of other genes and environmental influences.

Genetic testing and counselling is crucial for patients with FAP to facilitate understanding of cancer risk, help inform decisions about treatment and surveillance, and advise regarding reproductive concerns. Testing is typically performed on DNA from blood leucocytes. If the individual is part of a family with a known *FAP* mutation, it is possible to look for the specific mutation. In other cases, the entire gene can be analyzed.

Because FAP is both rare and complex, it is best managed by a collaborative group of specialists. Registries can aid with identify-

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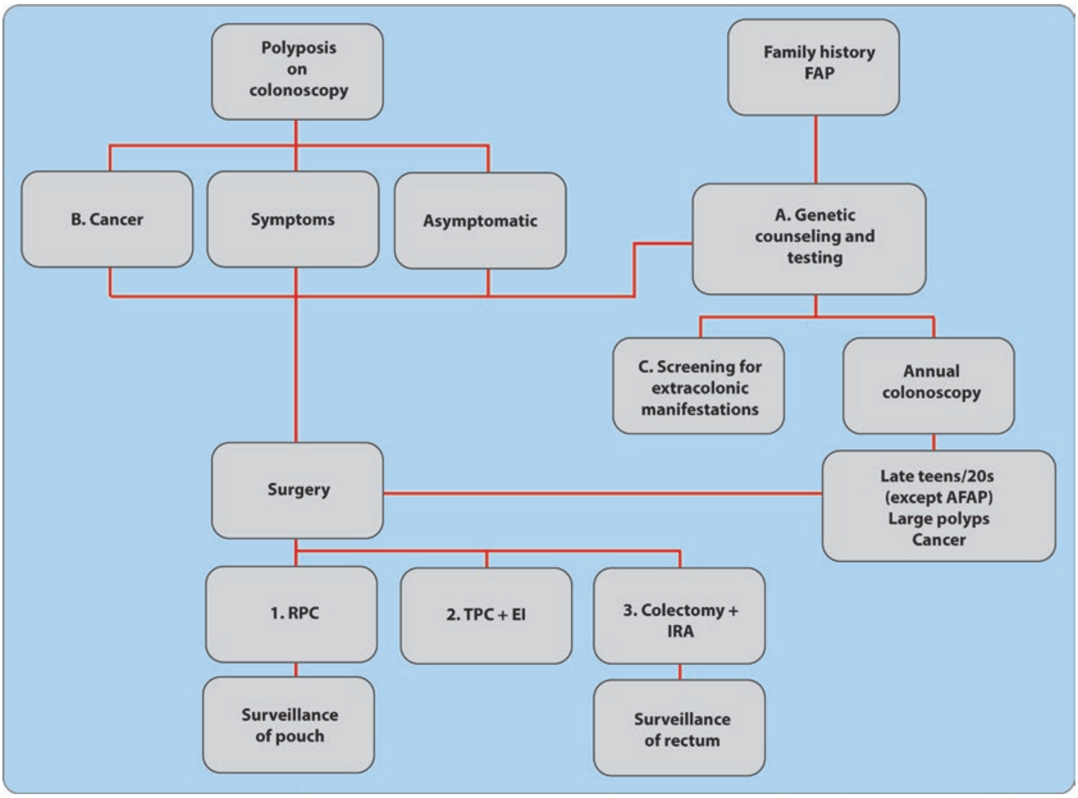

Fig. 60.1 Algorithm for familial adenomatous polyposis. *FAP* familial adenomatous polyposis, *APAP* attenuated familial adenomatous polyposis, *TPC* total proctocolectomy, *EI* end ileostomy, *IRA* ileorectal anastomosis, *RPC* restorative proctocolectomy

ing family members in need of genetic testing, facilitate surveillance for FAP patients and their families, and promote research. Collaboration between registries can be particularly helpful because of small numbers of patients. Participation in registries is associated with higher rates of participation in screening and consequently substantially lower incidence and mortality in FAP patients.

B. Colorectal Cancer

Colorectal cancer in FAP follows the classical adenoma to carcinoma sequence. As a tumor suppressor gene, *APC* deactivation occurs only after both alleles are damaged; the first one is inherited in the mutated form and the second is lost or damaged by a somatic event. Without prophylactic risk-reducing surgery, the risk of colon cancer in FAP is nearly 100% by age 40, although fortunately cancer is rare in FAP patients before age 20. In those individuals with newly diagnosed FAP who do not have a family history and therefore have not undergone surveillance, the incidence of colon cancer is 25%.

Table 60.1 Differences between FAP and AFAP

	FAP	AFAP
Number of polyps	>100	10–99 (average 30)
Polyp distribution	Pan-colonic	Typically right sided
Average age of polyp onset	Mid-teens	20s–40s
Average age of CRC diagnosis	39	55
Incidence of CRC	>95% if untreated	~70%

In the attenuated form of FAP, adenoma and carcinoma development is generally delayed by one to two decades. The cumulative risk of CRC in AFAP by age 80 is 70% with the mean age of diagnosis at 58 years. Differences between classical FAP and AFAP are summarized in Table 60.1. Because polyp

distribution in AFAP tends to be more right-sided, full colonoscopy should be used for screening rather than sigmoidoscopy. In cases of AFAP in which the colon can be completely cleared endoscopically and there is reliable surveillance, it may be possible to avoid surgery completely. When they do require surgery, AFAP patients can nearly always undergo colectomy with ileorectal anastomosis (see below).

Patients who are known to have FAP, or those who are at risk, based on family history, should have screening via annual sigmoidoscopy or colonoscopy. Colonoscopy is preferred for patients with AFAP as this condition predominantly features right sided polyps. This surveillance should begin at puberty or earlier if there are symptoms that could be related to polyposis such as diarrhea, bleeding, or pain. In those with FAP surveyed with sigmoidoscopy, once an adenoma is identified, full colonoscopy should be completed. In combination with surgery, surveillance nearly eliminates the risk of death from colorectal cancer in FAP.

C. Extracolonic Manifestations

Because of the abundance of extracolonic and extraintestinal manifestations of FAP, patients should undergo a variety of surveillance tests on a regular basis. These tests and appropriate intervals are detailed in Table 60.2.

1. Stomach and Small Bowel

Fundic gland polyps are very common in FAP patients, but adenomas and carcinoma of the stomach are rare. These fundic gland polyps represent hyperplasia of the fundic glands and are considered to be hamartomas. They are typically 1–10 mm in size and may have dysplasia on biopsy but do not confer an increased risk of gastric cancer and do not require removal. Adenomas are present in the stomach of 10% of FAP patients. These can undergo malignant degeneration and become cancerous, though this is rare.

Patients with FAP are at high risk for small bowel adenomas and carcinomas, particularly in the peri-ampullary region, occurring in more than half of FAP patients. The lifetime risk of duodenal cancer is approximately 3–5% and it is one of the leading causes of death in FAP patients who have undergone colectomy. It typically occurs between the ages of 45 and 55 years.

Patients should undergo upper endoscopy and duodenoscopy with a side-viewing scope starting at 25–30 years of age. Duodenal polyps are graded via the

Table 60.2 Surveillance for FAP patients

System	Features	Screening	Interval
Upper GI tract	Adenomas	EGD	Beginning at age 20; follow-up dependent on findings but typically 1–4 years
	Carcinomas		
	Fundic gland polyps		
Colon and rectum	Adenomas	Colonoscopy	Annually beginning at 12 years of age
	Cancer		
Connective tissue	Osteomas	None	–
	Desmoid	CT or abdominal ultrasound	No clear protocol
Skin	Epidermoid cyst	None	–
Endocrine	Adrenal adenoma/carcinoma	None	–
	Thyroid carcinoma	Thyroid ultrasound	Every 1–2 years
Hepatobiliary	Biliary tract carcinoma	None	–
	Pancreas	None	–
	Hepatoblastoma	Ultrasound and α-fetoprotein	No clear protocol; suggested every 6–12 months from infancy to age 5–7
Central nervous system	CHRPE	None	–
	Brain tumors	None	–

Table 60.3 Spigelman stage for duodenal polyps

Polyps	1 point	2 points	3 points
Number	<4	5–20	>20
Size (mm)	0–4	5–10	>10
Histology	Tubular	Tubulovillous	Villous
Dysplasia	Mild	Moderate	Severe
Total points	*Stage*	*Surveillance frequency*	
0	0	Every 4 years	
1–4	I	Every 2–3 years	
5–6	II	Every 1–3 years	
7–8	III	Every 6–12 months	
9–12	IV	Expert surveillance every 3–6 months; surgical evaluation for intervention	

Spigelman criteria (Table 60.3), which predicts cancer risk and dictates follow up. In patients with Spigelman stage IV polyps, the risk for cancer in the next ten years is estimated at 36%, and patients should be considered for pancreas preserving duodenectomy. If cancer is present or strongly suspected, a Whipple should be performed. Adenomas can be managed with transduodenal polypectomy. An endoscopist experienced in advanced techniques such as endoscopic mucosal resection is helpful for managing these patients.

2. Thyroid

   Thyroid cancer appears to be increased in patients with FAP. The cribriform-morular variant (CMV) is particularly associated with FAP, but papillary thyroid cancer is more common. There is also an increase in nodular thyroid and other benign findings in FAP patients, though this may be due to increased screening. Thyroid abnormalities appear to be more common in female patients, mirroring the distribution in non-FAP related cases. The optimal regimen for thyroid screening has not been determined but repeating it based on findings or on an annual or every 2 year basis has been suggested.

3. Liver

   Hepatoblastoma can occur in infants and children with FAP, with most occurring before age 3. The estimated prevalence in FAP patients is 1.6% and there is a male predominance. There may be a correlation with mutations at the 5′ end of the *APC* gene. Serum α-fetoprotein and hepatic ultrasound may be used for screening. Though it has been suggested that this requires genetic testing in infants, it is still possible to perform the screening presumptively and defer genetic testing until the patient is older, with appropriate counseling. Adenomatous changes and cancer in the gallbladder, biliary system, and pancreas have all been described. There is no specific surveillance regimen recommended for these organs.

4. Adrenal

   The incidence of adrenal adenoma and carcinoma in FAP patients is about four times that of the general population. Since FAP patients are often undergoing imaging for other reasons, these are often found incidentally and should be treated based on size criteria.

5. Skin

   Epidermoid cysts and fibromas are benign lesions that may appear in FAP patients. They lack malignant potential and are treated only if there is cosmetic or functional concern.

6. Bone

   Osteomas and supranumerary teeth are part of the clinical spectrum of FAP. Osteomas most commonly grow in the jaw and skull but can occur anywhere in the body. They do not have malignant potential but since they may occur prior to the development of colorectal polyps, they can be a marker for FAP.

7. Eyes

   Congenital-hypertrophy of the retinal pigmented epithelium (CHRPE) is present in some individuals with FAP. It has no known clinical significance but in the family members of the two-thirds of FAP patients who have them, the presence of the lesions may act as a marker of FAP. Isolated CHRPE lesions occur in the general population but the presence of multiple or bilateral lesions is suggestive of FAP.

8. Brain

   Turcot syndrome is the eponym used to describe the subset of FAP patients who have brain tumors. Typically, these tumors are medulloblastomas. The risk in FAP patients is approximately 1%.

9. Desmoids

   Desmoid tumors are benign fibroblastic soft tissue tumors; though they are not malignant, they can be locally aggressive and become symptomatic based on size, compression of adjacent organs, or erosion into nearby structures including blood vessels and ureters. The incidence of desmoids in FAP patients is 850 times higher compared to the general population and affect 10–25% of FAP patients.

   They may occur on the trunk or extremities, but intra-abdominal tumors, which represent more than half of the desmoids in FAP present a more significant clinical challenge. Typically, desmoid tumors grow in the abdominal wall or small bowel mesentery of FAP patients. Their appearance can range from plaque-like lesions that form puckering in the mesentery leading to kinking, to well circumscribed, large tumors.

   About one-third of FAP patients develop desmoid disease, though only 3% have intra-abdominal desmoids at the time of their first surgery. Risk factors for desmoid tumors include female sex, family history of desmoid tumors, *APC* mutation at the 3′ end of the gene, and previous abdominal surgery. The majority of desmoid tumors in FAP, 68–83%, occur after surgery.

   Treatment strategies include NSAIDs, anti-estrogens, radiation, chemotherapy, and surgery. Surgical intervention should be used cautiously as it may be difficult to safely remove the tumor and the trauma of the surgery itself likely predisposes to recurrence. The overall high recurrence rate and variable clinical course of desmoids suggests that surgery should be used cautiously and only when necessary. Complications from desmoids include bowel obstruction, ureteral obstruction, fistulas to the skin or adjacent organs, erosion into nearby blood vessels, and necrotic degeneration with abscess.

D. Surgical Options

In classical FAP, the risk of colorectal cancer without risk-reducing surgery is nearly 100%. However, surgical procedures and timing should be individualized based on the clinical situation as well as patient preferences.

1. Restorative Proctocolectomy

   Restorative Proctocolectomy with ileal pouch anal anastomosis (IPAA) is generally considered the procedure of choice in FAP. It nearly eliminates the risk of cancer in the colon and rectum.

   When first described, IPAA included a mucosectomy and a hand sewn anastomosis between the pouch and anal mucosa at the dentate line. The theoretical advantage to this approach is that all “at risk” mucosa is removed. However, in reality, small islands of mucosa are likely left behind during the dissection and can develop cancer that is now extra-luminal. The introduction of circular staplers allowed for a technically easier procedure that resulted in a better functional outcome while allowing for endoscopic surveillance of the 2–3 cm residual rectal cuff.

   Adenomas occur in the anal transition zone at a rate of 28–51% after stapled anastomosis and 10–22% after mucosectomy with hand-sewn anastomosis. Cancer is rare, but does occur at a rate of 1–2% following either mucosectomy or stapled anastomosis, so continued surveillance is

critical. Polyps in the pouch can be endoscopically managed or locally excised, but large adenomas and carcinoma in the pouch, or profuse polyposis may warrant pouch excision.

After IPAA, patients generally have five to six bowel movements per day, and one overnight. There is a higher incidence of seepage of mucous and stool, perianal irritation, and anastomotic stenosis in handsewn pouches and it seems that those with stapled pouches have better function. However, patient satisfaction is generally equivalent between the two techniques.

2. Total Proctocolectomy (TPC) with End-Ileostomy (EI)

   Proctocolectomy with end-ileostomy is appropriate for patients who are unable or unwilling to manage life with an ileal pouch. Those with low rectal cancer near or involving the sphincter are not candidates for restorative surgery. Patients with underlying sphincter dysfunction or incontinence should be counselled about functional result of restorative surgery and may have better quality of life with permanent ileostomy. In patients with pre-existing mesenteric desmoids, it may not be possible to construct a pouch or bring it into the pelvis. At the same time, these patients may not be appropriate for colectomy with ileorectal anastomosis and therefore TPC with EI is a good choice.

3. Colectomy with Ileorectal Anastomosis (IRA)

   The decision to leave residual rectum in a patient with FAP should be guided by their phenotype, willingness to undergo surveillance of the residual rectum, and patient preference.

   Polyp burden both throughout the colon and in the rectum are both considered when selecting patients for this approach. In general, patients with fewer than 20 adenomas in the rectum that can be completely removed endoscopically are good candidates for this procedure. Those with <1000 colon polyps and <5 rectal polyps nearly always are able to retain their rectums permanently. It has the advantage of avoiding the pelvic dissection and patients generally have excellent control of bowel function and with 2–4 bowel movements per day and an easily surveyed residual rectum.

   IRA may also be performed as a bridging procedure in some patients who eventually plan to have a completion colectomy with or without a restorative procedure. This is most commonly considered in young women with concerns regarding childbearing who may wish to delay pelvic surgery.

   The cumulative risk of rectal cancer after IRA in FAP ranges from 7% to 15%. Indications for completion proctectomy include cancer, dysplasia, large polyps, and the inability to completely remove all polyps endoscopically.

E. Other Surgical Considerations

Laparoscopy

Surgery may be performed via traditional open technique or laparoscopically. There are a variety of modifications to laparoscopy including hand assist and single incision techniques, and while many surgeons prefer to create an IPAA through a lower midline or Pfannenstiel incision, using the stoma site has also been described. Laparoscopy has the potential benefits of decreased post-operative pain, shorter hospitalization, and quicker return to pre-operative function. There are no differences in complication rates or functional outcomes. For some patients, the cosmetic benefit is also appealing. For FAP patients in particular, it has been suggested that laparoscopy reduces the risk of desmoid tumors by decreasing surgical trauma but the data is mixed. For young women, there may also be a benefit to fertility with laparoscopic IPAA but this is primarily extrapolated from series where the majority of patients had pouch surgery for ulcerative colitis.

Desmoids

When intra-abdominal desmoids are present at the time of surgery, they can impair the ability to remove the colon if blood vessels are encased, to perform proctectomy, or to achieve adequate mesenteric length to perform anastomosis or IPAA. There is no evidence that colectomy with IRA leads to fewer desmoids than does RPC. Furthermore, the morbidity of desmoid tumors does not vary between those with IRA and RPC. The development of a desmoid tumor may alter surgical planning if a completion proctectomy is required later, but it generally does not preclude it.

Laparoscopy may be beneficial in minimizing the surgical trauma that may contribute to desmoid development. A large study from Italy suggested that the cumulative probability of desmoid development was 13% after open surgery versus 4% after laparoscopic surgery. Surgery at a younger age (<18) may also lead to desmoid development in female patients, which may influence decisions regarding the timing of surgery.

Timing of Surgery

For the majority of FAP patients, surgery is prophylactic. The goal is to prevent cancer from developing but physiologic, genotypic, social, and emotional factors also play a role. There are several situations in which delaying surgery is not feasible. In patients whose polyposis is so severe (>1000 polyps) that they cannot be adequately surveyed, surgery should be performed at an early age. If dysplasia or many large polyps are present surgery should not be unduly delayed. When adenoma associated symptoms including diarrhea, bleeding, malnutrition leading to growth delay are present, surgery should be performed promptly.

Patients with milder polyposis (100–1000 polyps) or those with AFAP (<100 polyps) may defer surgery as long as all adenomas are small (<9 mm), there is no high grade dysplasia, and they are motivated to continue regular surveillance. In AFAP patients with a very mild phenotype whose colons are able to be cleared colonoscopically and managed via polypectomy, surgery may be deferred indefinitely.

In general, most patients are recommended to undergo surgery between the ages of 18–25 when they have physical and emotional maturity, but still have low cancer risk. In patients who do not have prophylactic surgery, the mean age of CRC diagnosis is 39 years, with death occurring at 42 years. The risk of cancer prior to age 20 is estimated at 1%, but is as high as 32% at age 30.

Concerns about desmoids and fertility may also influence timing of surgery. Because desmoids appear to occur more frequently in women who undergo surgery at a younger age, it is reasonable to consider deferring surgery beyond age 18 when it is otherwise feasible, particularly in patients at high risk for desmoid tumors.

Fertility/Fecundity

Sexual function may be impaired by IPAA. Impotence and retrograde ejaculation are well defined complications of pelvic dissection in men. In women, about half report sexual dysfunction; this appears unrelated to pouch dysfunction.

Reduced fertility has also been reported in women who have undergone IPAA. Compared with ulcerative colitis patients, FAP patients who have undergone IPAA are not as severely affected. One study suggested that IRA had an equal impact on fertility compared with IPAA and neither desmoids nor cancer were associated with infertility. The few small series that have examined fertility problems after IPAA for FAP have identified widely varying rates from 17% to 62%. However, for some women who are concerned about their fertility, colectomy with IRA either as definitive treatment or as a bridge to proctectomy with or without IPAA after childbearing has been completed may be considered. Laparoscopy may also reduce the rates of adhesions following pelvic surgery and may decrease infertility rates so should be offered when feasible.

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61 Colonic Conditions: Lynch Syndrome

Matthew F. Kalady

Definitions and Classification of Terms

Lynch syndrome is defined by the presence of a pathogenic variant in one of the mismatch repair (MMR) genes *MLH1*, *MSH2*, *MSH6*, *PMS2*. Rarely, Lynch syndrome is caused by a mutation in *EPCAM*. The diagnosis is based on genetic test results. The germline mutation is heritable and dominant with the resultant phenotype marked by increased risk of colorectal and extracolonic cancers, which arise at a young age. The most common cancers associated with Lynch syndrome include colorectal, endometrial, ovarian, gastric, urinary epithelial, small bowel, pancreas, and skin. The gene mutations in Lynch syndrome result in lack of MMR protein expression and function and thus tumors are characterized by MMR deficiency (MMRd). MMRd is characterized molecularly by high microsatellite instability (MSI-H).

Before the exact genetic etiology was identified, clinicians and researchers developed clinical criteria to help identify, treat, and study patients who had commonly associated cancers that were prevalent in their families and at young ages. These criteria were developed at a meeting in Amsterdam and were thus termed Amsterdam criteria. Amsterdam II criteria include the following: (1) there should be at least 3 relatives with a Hereditary Nonpolyposis Colorectal Cancer (HNPCC)-related cancer; (2) at least two successive generations should be affected; (3) at least one affected individual is diagnosed before age 50; (4) Familial adenomatous polyposis is excluded. HNPCC-related cancers include those of the colorectum, endometrial, ovaries, stomach, small intestine, ureter or renal pelvis, pancreas, hepatobiliary system, brain, and skin sebaceous neoplasms. Affected people from families meeting Amsterdam criteria are diagnosed as having HNPCC. HNPCC by itself, does not diagnose Lynch syndrome, but rather identifies people at increased risk for cancer and those that should be evaluated for Lynch syndrome by genetic testing. Not all patients with Lynch syndrome have HNPCC, and not all HNPCC patients will have Lynch syndrome. Patients with HNPCC but without a germline confirmation of Lynch syndrome are at increased risk compared to the general population, but not as high as those with Lynch syndrome.

As stated above, MSI is the molecular hallmark of Lynch syndrome tumors. Patients whose families meet Amsterdam criteria but have a microsatellite stable tumor are diagnosed with Familial Colorectal Cancer Type X (FCC X). The people have an increased risk of

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cancer compared to the general population, but not as high at those with Lynch syndrome and cancers develop at a later age compared to those with Lynch syndrome. This chapter focuses on the algorithmic approach to the diagnosis and management of Lynch syndrome.

Refer to Algorithm in Fig. 61.1

Presentation and Clinical Situations

A. Lynch syndrome evaluation and management depends on the clinical situation. Patients mainly either present with a lesion (i.e., colorectal adenoma or cancer, or extracolonic cancer) and a diagnosis needs to be made; or patients present with a Lynch syndrome diagnosis after undergoing counseling and genetic testing due to a relative being diagnosed with Lynch syndrome. Both of these situations are discussed in the algorithm.

Suspected Lynch Syndrome

B. Detailed Personal and Family History

Since Lynch syndrome is a genetic predisposition to multiple cancers both in the individual and in the family, a detailed personal and family history is mandatory. An adequate family history should include information on family members from at least 3 generations. The collection of information always starts with the current patient, and expands primarily to first-degree relatives, but also should include second- and third-degree relatives. For each family member, the presence of colorectal polyps, colorectal cancers, and any extracolonic cancers should be recorded, including the age at which each lesion was detected. A family tree or pedigree drawing allows for a visual representation of the cancers within a family and can be used to analyze particular trends or inheritance patterns within the family. A written pedigree

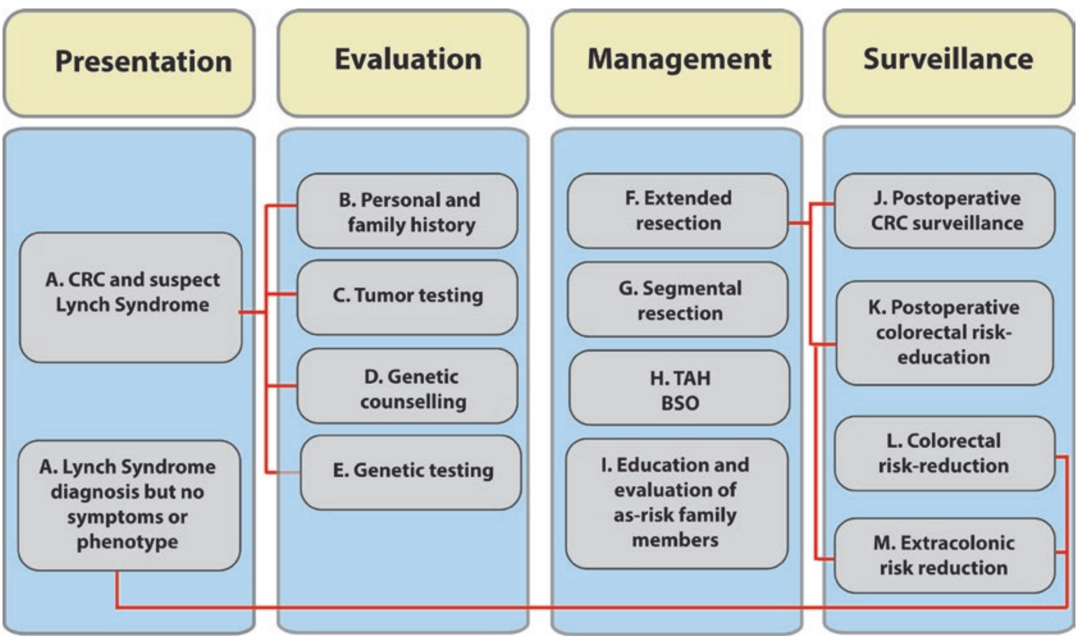

Fig. 61.1 Algorithm. Abbreviations: *MSI* microsatellite instability, *MSI-H* high microsatellite instability, *MMR* mismatch repair, *MMRd* mismatch repair deficiency, *IHC* immunohistochemistry, *TAH* total abdominal hysterectomy, *BSO* bilateral salpingo-oophorectomy, *IPAA* ileal pouch-anal anastomosis

also creates a structure that can be easily updated as new information becomes available. It is important to note that the family history is only as accurate as the source and the history should be validated by medical records when possible.

Patients with a history suggestive of Lynch syndrome should be evaluated further. Multiple guidelines have been developed as a way to identify who should undergo additional testing. Amsterdam criteria, as discussed above, have been widely used. Amsterdam II criteria are fairly sensitive at about 85% for identifying Lynch syndrome, but are only about 20% specific. The revised Bethesda guidelines utilize history as well as tumor histologic findings to determine who should undergo tumor MSI testing as a screen of Lynch. Revised Bethesda criteria are the following: (1) colorectal cancer diagnosed in a patient who is less than 50 years of age; (2) the presence of synchronous, metachronous colorectal, or other HNPCC-associated tumors, regardless of age; (3) colorectal cancer with the MSI-H histology diagnosed in a patient who is less than 60 years of age; (4) colorectal cancer diagnosed in one or more first-degree relatives with an HNPCC-related tumor, with one of the cancers being diagnosed under age 50 years; (5) colorectal cancer diagnosed in two or more first- or second-degree relatives with HNPCC-related tumors, regardless of age.

Since the goal is to identify and survey patients before cancers develop, it is prudent to be more suspicious. In general, the author favors a low threshold to pursue additional evaluation for Lynch syndrome even if they do not meet all of the suggested criteria. The National Comprehensive Cancer Network recommends that colorectal cancers resected from all patients under the age of 70 undergo tumor testing as a screen for Lynch syndrome.

C. Tumor Testing

As mismatch repair deficiency (MMRd) is the underlying cause of Lynch syndrome, the first line of screening includes testing the tumor for MMRd. Tumor testing for MMR deficiency is more accurate and cost-effective at identifying potential Lynch syndrome patients compared to clinical criteria alone. The two ways of identifying MMRd are MSI in the tumor, or by measuring mismatch repair protein expression using immunohistochemistry (IHC). MSI is a PCR-based test using tumor DNA. IHC is an antibody based test applied to tumor sections on a slide. More than 90% of Lynch syndrome CRC will be MSI-H and lack of MMR protein expression.

Only about 15% of MMRd tumors result from the germline variants of Lynch syndrome. Across all colorectal cancers, microsatellite instability is most commonly caused by hypermethylation of the DNA promoter region of the *MLH1* gene which results in lack of expression and function MLH1 and thus results in MMRd. Thus, if MLH1 expression is lost on IHC, it is more commonly the result of hypermethylation rather than Lynch syndrome, depending on the clinical situation. Two tumor tests are commonly used to distinguish the difference between sporadic and Lynch-associated MLH1 loss. Hypermethylation of the promoter region can be measured directly. Secondly, tumors can be tested for a mutation in the *BRAF* oncogene. Most sporadic MMRd tumors have *BRAF* mutations. Thus, mutated *BRAF* is more consistent with a sporadic tumor, while wild-type *BRAF* suggests additional evaluation for Lynch syndrome. If expression of one of the other MMR proteins (MSH2, MSH6, or PMS2) is lost, then genetic testing for that specific associated gene is done.

Tumor testing is ideally done on the tumor biopsy at the time of cancer diagnosis so that appropriate work-up and evaluation can be done before surgery. A known diagnosis of Lynch syndrome affects surgical management (see below). Unfortunately, it is often not practical or feasible to perform tumor testing on every single colorectal cancer prior to surgery. However, if there is suspicion for Lynch or another hereditary colorectal cancer

syndrome, preoperative tumor testing with subsequent genetic counseling and testing as appropriate should be done. Examples where preoperative tumor testing should be done include patients meeting Amsterdam criteria, histologic findings suggestive of Lynch syndrome, or colorectal cancer at a young age.

D. Genetic Counseling

If tumor testing is consistent with a possible Lynch syndrome diagnosis, genetic counseling is recommended. These services are most appropriately provided by a medical geneticist or genetic counselor. Based on the personal and family history, counselors can determine which genetic test is most appropriate (if any) and also which family members should be tested. Counseling should provide an overview of the suspected syndrome, the technical aspects and accuracy of the test, and the possible results. The discussion should include information about economic considerations, possibility of genetic discrimination, confidentiality, utilization of test results, and alternatives to genetic testing. An assessment of the potential of psychosocial issues that may arise for patients and their families while going through this process is also essential. Lastly, there must be a plan in place to communicate the results. All of this information should empower patients to make an informed choice whether or not to undergo genetic testing. Due to the complexity and implications of the interpreting genetic test results, counseling should be performed by a trained professional.

E. Genetic Testing

After counseling, genetic testing is offered to the appropriate patients and conducted with informed consent. Germline testing is routinely done on a blood sample, but can also be performed using saliva. There are multiple commercial vendors who perform these tests. When tumor testing is not available to isolate a particular gene for testing, other strategies are employed. Some counselors will test all four MMR genes. Recently, several commercial gene panel tests have been developed and utilized for broader identification of hereditary based cancers, including CRC.

Management of Lynch Syndrome

Surgical decision-making in Lynch syndrome patients with colorectal cancer is complex and involves consideration of oncologic principles, disease prognosis, future cancer risk reduction, expected functional outcomes and quality of life, and patient wishes. The cornerstone of treatment is the surgical resection of the cancer and the surrounding colon according to oncologic principles. For sporadic colorectal cancers, resection is usually a segmental colectomy. However, for Lynch syndrome patients who develop colorectal cancer, the concept of extended colectomy as a prophylactic measure to remove more colon than would be removed for a simple segmental colectomy to reduce metachronous cancer risk is a guiding principle.

F. Surgical Management: Extended Resection

Multiple organizations including the National Comprehensive Cancer Network, The American Society of Colon and Rectal Surgeons, and a US Multi-Society Taskforce recommend extended colectomy for patients with colon cancer and Lynch syndrome. This recommendation is based mainly on the metachronous colon cancer risk. There are no randomized prospective trials comparing colorectal cancer risk after extended colectomy and segmental colectomy. However, there are multiple retrospective analyses that support significant colon cancer risk reduction after a total colectomy and ileorectal anastomosis compared to a segmental colectomy. For patients undergoing a segmental colectomy, the reported risk of metachronous cancer is approximately 16–25% at around 10 years. In one large international registry study, the risk was extrapolated over time and as expected increased to 16%, 41%, and 62% at 10, 20, and 30 years, respectively. The risk of metachronous rectal cancer after colectomy and ileorectal anastomosis is approximately 5–10% at 10 years.

An argument against extended colectomy that is sometimes made is that colonoscopy can adequately survey and control neoplasia in any residual colon after a segmental colectomy.

Again, there is no prospective data that supports or refutes that statement. In fact, this may seem logical given that colonoscopy in Lynch syndrome patients without a cancer does reduce the incidence and death from colorectal cancer. However, there are several practical challenges to a successful postoperative surveillance regimen. In fact, interval cancers develop in 35% of cases under surveillance. Several factors may contribute to this phenomenon such as poor patient compliance, poor quality colonoscopy, suboptimal bowel preparation, experience of the endoscopist, and the more aggressive adenoma-to-carcinoma sequence seen in Lynch syndrome.

Non-cancer related considerations in surgical decision making are quality of life and bowel functional expectations. Proponents of segmental resection site concern over worse function as more bowel is removed. The data on this topic is also limited, but there seems to be a consensus that although a total colectomy yields more frequent bowel movements, the overall quality of life is not different compared to a segmental colectomy.

Decision-making for rectal cancer surgery in Lynch syndrome is more complex than colon cancer. Options include treating the primary cancer alone by proctectomy, or an extended resection to remove all colorectal at-risk mucosa via a total proctocolectomy (TPC) with end ileostomy or restorative ileal pouch-anal anastomosis (IPAA). Proctectomy without colectomy leaves a substantial metachronous colon cancer risk of approximately 15–20% at 10 years, even under surveillance. Again, the risk increases over time after resection with metachronous colon cancer estimates at 47% at 20 years, and 69% at 30 years.

Rectal cancer in Lynch syndrome should be managed like any other rectal cancer in terms of indications for multimodality therapy and oncologic principles. However, the need for pelvic radiation should be considered when considering a TPC and IPAA. Although there is concern about morbidity of an IPAA after pelvic radiation, an analysis of more than 150 IPAA patients (not Lynch syndrome) who received preoperative pelvic radiation showed no significant elevation of 30-day morbidity rate compared to patients who did not receive pelvic radiation. It is important to note, however, that data regarding the long-term functional outcome of an IPAA performed after pelvic radiation is sparse. It is also important to assiduously avoid postoperative radiation.

Another consideration in rectal cancer decision-making is the difficulty of managing a metachronous colon cancer after a proctectomy and coloanal anastomosis. Resecting a coloanal anastomosis in a redo pelvis is challenging and associated with increased morbidity compared to pelvic dissection at a primary total proctocolectomy.

Of course, there are functional consequences after an IPAA compared to a proctectomy and coloanal anastomosis. A patient with an IPAA can expect to have more frequent bowel movements and a higher incidence of incontinence and seepage compared to a coloanal anastomosis. The morbidity associated with pelvic dissection and ileal pouch construction must be considered. This is a technically challenging procedure and should only be performed by those with specialized surgical training and expertise.

Taking all of the above information together, the decision to perform a proctectomy alone or a TPC and IPAA for rectal cancer in Lynch syndrome remains controversial. The author favors TPC with IPAA for rectal cancer in healthy Lynch syndrome patients with normal sphincter function. If there is advanced disease and the likelihood of dying from recurrent disease outweighs the likelihood of metachronous second primary cancer, a proctectomy should be considered. Each case must be evaluated as an individual patient. The patient's age, medical comorbidities, preoperative sphincter function, and the feasibility of future surveillance compliance factor into the decision.

G. Surgical Management: Segmental Resection

Recommendations for surgical decision-making are not absolutes. Each patient needs to be considered as an individual. For colon cancer, there are situations where a segmental

resection may be considered. Examples include an unhealthy patient who cannot tolerate an extended resection or the physiologic consequences after a total colectomy (e.g. renal impairment where dehydration could lead to renal failure); other health conditions that limit life expectancy more so than the risk of a second Lynch-related colorectal cancer; stage IV colon cancer such that risk of mortality from current disease is greater than that from metachronous cancer. Another indication is patient choice in the setting of adequate information and counseling. There are patients who absolutely refuse the extended prophylactic colectomy and accept the need for continued intense surveillance and metachronous risk. For rectal cancers, the same conditions above apply, but additional considerations are given to sphincter function. Patients with weak sphincter function may have better bowel function after proctectomy alone compared to IPAA. A TPC and end ileostomy could also be considered for patients with poor sphincter function. One undebatable issue in the decision to do a segmental colectomy is the patient's understanding and willingness to undergo annual colonoscopic surveillance. If a patient is not willing or non-compliant with surveillance recommendations, this is a contraindication to segmental colectomy.

H. Total Abdominal Hysterectomy and Bilateral salpingo-oophorectomy

For women, once beyond child-bearing age or if she have decided that she has completed her family, a prophylactic TAH/BSO should be considered. A gynecologic oncologist should be part of the Lynch syndrome care team to discuss the risk, benefits, and expected hormonal changes after this operation as well as to do the surgery. Retrospective studies demonstrate risk-reduction in uterine and ovarian cancer following prophylactic TAH-BSO.

I. Education and Evaluation of at-risk Family Members

Since Lynch syndrome is an autosomal dominantly inherited syndrome, all first-degree relatives of an affected individual have a 50% chance of also having Lynch syndrome. Patients are instructed to discuss this with family members and encourage them to attend clinical appointments with the patient. Consultations of at-risk family members with the physicians and/or genetic counseling is offered and strongly encouraged. For privacy issues, the physician cannot directly reach out to at-risk family members, but should aggressively work through their patients to provide education and support so that family members are appropriately evaluated.

J. Post-operative Surveillance

After surgery for colorectal cancer, there are two aspects to post-operative surveillance. The first is the standard of care surveillance after colorectal cancer resection including physical exam and history, serum CEA, and imaging at defined intervals based on cancer stage (this is outside the scope of this chapter and discussed elsewhere).

K. Post-Operative Colorectal Risk Reduction after Colorectal Surgery

The second aspect of surveillance is inherent to Lynch syndrome. As the entire colorectum is at increased risk for developing adenocarcinoma, any remaining colon or rectum must be surveyed annually by endoscopy with removal of adenomas. If a segmental colectomy was done, then a mechanical bowel preparation is required before colonoscopy. If a total abdominal colectomy and an ileorectal anastomosis were done, then a simple enema is given before flexible proctoscopy as a routine office procedure.

Lynch Syndrome Diagnosis Without Clinical Symptoms or Phenotype

Detailed Personal and Family History (see discussion in B). Education should be provided about the associated cancer risks associated with Lynch syndrome and patients are encouraged to involve family members. If the patient agrees to share information, education and counseling should be offered to all at-risk family members (see discussion in I).

Table 61.1 Cancer Risk to Age 70 in Individuals with Lynch Syndrome Compared to the General Population

Cancer type	Risk in general population	*MLH1* or *MSH2*		*MSH6*		*PMS2*	
		Risk	Mean age of onset (years)	Risk	Mean age of onset (years)	Risk	Mean age of onset (years)
Colorectal	5.5%	52–82%	44–61	10–22%	54	15–20%	61–66
Endometrium	2.7%	25–60%	48–62	16–26%	55	15%	49
Stomach	<1%	6–13%	56	< 3%	63	a	70–78
Ovary	1.6%	4–24%	42.5	1–11%	46	a	42
Hepatobiliary	<1%	1–4%	50–57	NR	NR	a	NR
Urinary tract	<1%	1–7%	54–60	< 1%	65	a	NR
Small bowel	<1%	3–6%	47–49	NR	54	a	59
Brain/CNS	<1%	1–3%	50	NR	NR	a	45
Sebaceous neoplasms	<1%	1–9%	NR	NR	NR	NR	NR
Pancreas	<1%	1–6%	NR	NR	NR	NR	NR

Adapted from National Comprehensive Cancer Network (NCCN) Guidelines 2.2016
NR not reported
[a]The combined risk for renal pelvic, stomach, ovary, small bowel, ureter and brain in PMS2 carriers is 6% to age 70 years

L. Colorectal Cancer Risk Reduction before Neoplasia: Surveillance Colonoscopy and Polypectomy

The management goal of Lynch syndrome patients and families is to reduce cancer development and deaths from cancer. Colonoscopy and polypectomy reduces both the incidence of cancer and deaths from cancer in Lynch syndrome patients by 62% and 72%, respectively. Lynch syndrome adenomas and cancers tend to progress more rapidly than sporadic colorectal adenomas and cancers and thus screening intervals are more frequent in Lynch syndrome. Most guidelines recommend surveillance colonoscopy every 1–2 years, starting at age 20–25. At the Cleveland Clinic Sanford R. Weiss Center, MD, Center for Hereditary Colorectal Neoplasia, we generally recommend colonoscopy every 2 years until age 40, then yearly after that. This is because the average age of colorectal cancer in Lynch syndrome is in the early 40s. If there is colorectal cancer at a younger age in the family, one-year intervals are started 10 years earlier than the first CRC in the family. Also, if an adenoma is detected on colonoscopy, the interval is shortened to one year.

M. Extracolonic Risk Reduction

Once a diagnosis of Lynch syndrome is established, the physician must understand the implications or cancer risk in other organ systems. This can be after the diagnosis is made following colorectal cancer resection, or with a genetic diagnosis before any clinical manifestations. In either situation, the approach is the same. Approximate risks of colorectal and extracolonic cancer development to age 70, compared to the general population is given in Table 61.1. After colorectal cancer, the most common cancer is endometrial cancer. Prophylactic TAH/BSO should be considered when a woman is done child-bearing. Although there are no prospective trials that demonstrate that endometrial screening decreases cancer risk, the literature suggests a benefit. Expert opinion recommendations include offering screening by annual pelvic exam and endometrial biopsy annually starting at age 30–35 years. Ovarian cancer screening should be performed at the same time by transvaginal ultrasound. Women with Lynch syndrome should be educated regarding symptoms of endometrial cancer, including abnormal uterine bleeding and pain.

Similarly, there is no evidence for gastric or small bowel screening, but expert opinion recommends an esophagoduodenoscopy at age 30–35 years with biopsy of the antrum and testing for *H. pylori* infection and treatment when found. If no neoplasia is seen, consideration should be given to repeat exam in 2–3 years, based on individual and family risk factors. Urinalysis is a simple non-invasive screening test of urinary epithelial neoplasms and should be done annually starting at age 30–35 years. Microscopic hematuria should trigger further evaluation. Skin examination for sebaceous adenomas and adenocarcinomas is also a simple, non-invasive evaluation that is recommended annually beginning at diagnosis. There are no recommendations for routine screening for cancers of the small bowel, hepatobiliary tree, or pancreas.

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Malignant Colon Polyps

62

Andrea M. Petrucci and Mariana Berho

Refer to Algorithm in Fig. 62.1

A. Non-invasive Polyps

Carcinoma in situ, high-grade dysplasia or intramucosal adenocarcinoma are all terms used to describe an adenomatous polyp displaying a high degree of cellular and architectural atypia that is confined to the lamina propria. The mucosal lining of the colon is divided into 3 components: the epithelium, the lamina propria and the muscularis mucosa. While in adenomas with high grade dysplasia/carcinoma in situ the lamina propria is not involved by tumor, intramucosal adenocarcinoma is characterized by spillage of the neoplastic cells beyond the basement membranes of the colonic crypts into the lamina propria. Due to absence of lymphatics in the lamina propria of the colon and rectum, none of these lesions have metastatic potential. The TNM classification groups these lesions into the Tis category and although they have the potential for invasion into the wall of the colon/rectum, polypectomy is sufficient if completely resected.

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B. Malignant Polyps

A "malignant" polyp is defined as the presence of adenocarcinoma that extends beyond the basement membrane. It is important to assess specific characteristics of the polyp in order to decide whether further, more aggressive treatment is needed for adequate removal. Invasive polyps can be pedunculated (C) or sessile (D). Pedunculated polyps contain a head, neck and stalk whereas sessile polyps are flat. In addition to the morphology of the polyp, important histopathological features including grade of differentiation, the presence of lymphovascular invasion, perineural invasion or tumor budding as well as inadequate resection margins (<2 mm) all play a very important role in predicting more aggressive disease in invasive polyps which will be discussed later.

C. Pedunculated Polyps

Adenocarcinoma in a pedunculated polyp is differently managed according to the location of the invasive cancer in the polyp. The Haggitt's classification was first described by Haggitt et al. in 1985 and is used to assess adenocarcinoma that invades into the submucosa in pedunculated polyps. It is a 4-level classification system where levels 1 through 4 indicate adenocarcinoma limited to the head, neck, stalk and base of the polyp respectively (Fig. 62.2). Pedunculated polyps of Haggitt's level 1–3 have a <1% risk of lymph node metastasis therefore can be managed by

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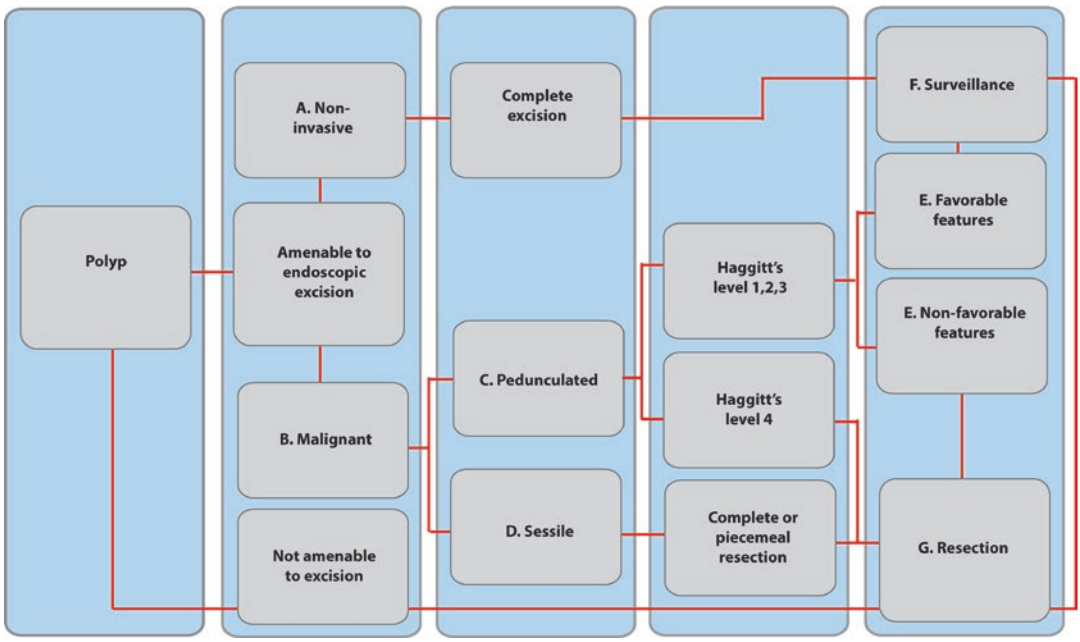

Fig. 62.1 Algorithm for malignant colonic polyps

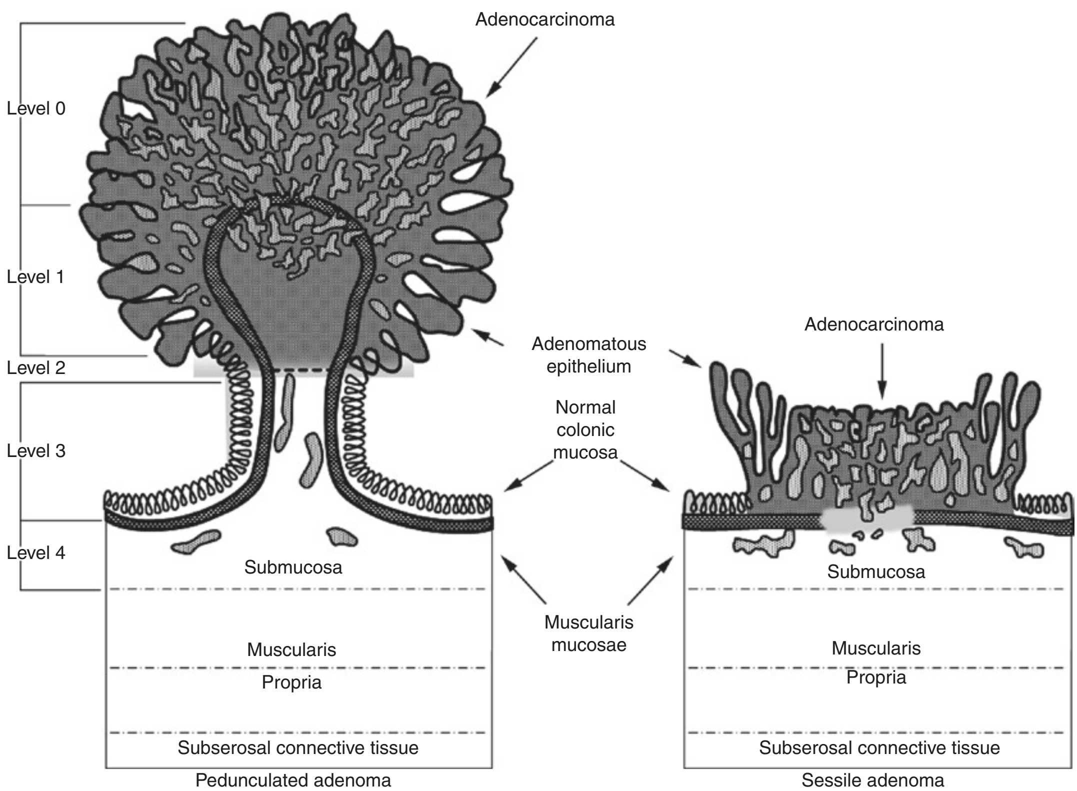

Fig. 62.2 Demonstration of the different levels of invasion between a pedunculated (right) and a sessile (left) adenoma. (With permission Nivatvongs 2002 © Elsevier)

simple polypectomy, given that they have favorable histological features. Haggitt's level 4 is equivalent to a sessile polyp and they are managed similarly. Any suspicious polyp should be tattooed at the site in order to locate it as needed.

D. Sessile Polyps

Adenocarcinoma in a sessile polyp is usually managed with surgical resection, to include a formal lymphadenectomy given the correlation between the level of invasion with the risk of further lymph node involvement. The level of invasion is characterized by the Kikuchi classification, which divides the submucosa into three depths of involvement: sm1 describes penetration of the upper third of the submucosa, sm2 involves the middle third and sm3 describes deep invasion to the lower third level, abutting the inner surface of the muscularis propria (Fig. 62.3). Tumor extending to the lower third were found to have up to a 23% risk of lymph node metastasis, hence the need for a formal bowel resection regardless if they were completely excised or removed piecemeal. It may not always be possible for the pathologist to assess the different levels of submucosal invasion depending on the quality of the specimen that is provided. A recent systematic review showed that submucosal invasion >1 mm corresponded with higher rates of lymph node metastasis, hence the need for formal surgical resection. Moreover, it has recently been suggested that the area of tumor involvement in which both width and depth of invasion are considered may be a better way to stratify risk of lymph node metastasis.

E. Features

As mentioned earlier, there are many factors that play a significant role in the management of malignant polyps. Size, morphology, margin status, degree of differentiation and histopathological features including lymphovascular and perineural invasion and tumor budding are all carefully assessed since they are all predictors of more aggressive tumors. Polyps <5 mm in size are usually benign; those ranging from 1.5 to 3.5 cm carry up to a 43% risk of malignancy and should be approached with caution. Margin status is a concern since it correlates with recurrence; polyps with involved margins or margins <1 mm from the cut edge correlates with recurrences ranging from 21 to 33% therefore the acceptable margin should be > or = to 2 mm. Traditionally, the grades of differentiation were described as grade 1 (well-differentiated), grade 2 (moderately-differentiated), grade 3 (poorly differentiated, including intestinal-type, signet ring cell or mucinous adenocarcinoma) and grade 4 (undifferentiated, including medullary carcinomas with high microsatellite instability). More recently the College of American Pathologists has recommended to categorize grade of differentiation in colorectal tumors into low grade (well and moderately differentiated adenocarcinoma) and high grade (poorly differentiated and undifferentiated adenocarcinoma). The degree of differentiation correlates

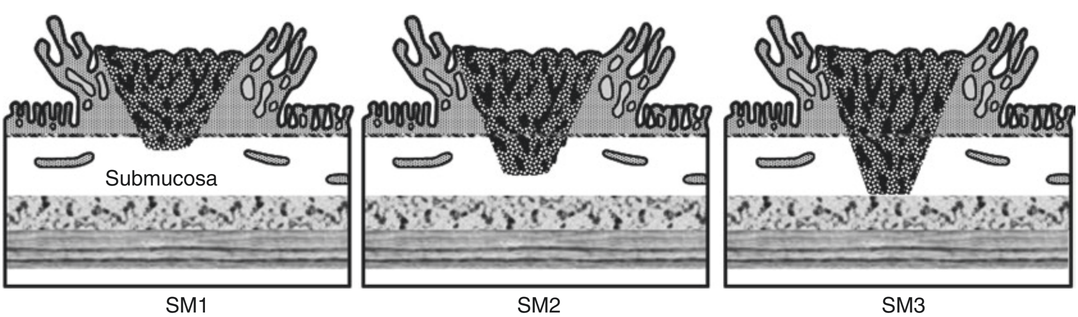

Fig. 62.3 Levels of submucosal invasion in a malignant sessile polyp. With author's permission. (With permission Nivatvongs 2002 © Elsevier)

with lymph node involvement. Blumberg et al. looked at pathological factors and the risk of lymph metastasis in rectal cancer and found that well-and -moderately differentiated tumors had a 14% risk of lymph node metastasis whereas the risk increased to 30% for poorly differentiated lesions. Lymphovascular invasion is an important prognostic factor. The lymphatic channels are usually found in the superficial submucosa and within the muscularis mucosa, which is why early lesions within the mucosa have a very low risk of lymph node involvement. Blumberg et al. also found that when lymphovascular invasion is present in a malignant polyp, there is a 33% chance of lymph node metastasis whereas those without lymphovascular invasion only had a 14% risk of positive nodes making this marker a poor prognostic factor. Although tumor budding, which refers to a small clusters of undifferentiated cancer cells, has been found to be a poor prognosticator, its utility in clinical practice is limited due to the lack of standardization in the pathological assessment.

In addition, microstaging of malignant polyps to include the depth and width of malignant invasion helps predict lymph node metastasis. Ueno et al. showed that a depth of ≥2000 um and a width ≥ of 4000 um correlated with a 18.2% and a 17.1% risk of lymph node metastasis respectively, compared to a <5% risk in polyps with invasion below these values, making these useful histopathologic features to consider.

F. Surveillance

According to the 2016 National Comprehensive Cancer Network (NCCN) guidelines, surveillance after a polypectomy for Tis/T1N0M0 malignant lesion consists of a colonoscopy at 1 year following removal. If at the time of colonoscopy, there is no sign of recurrence or advanced adenoma, the interval can be extended to 3 years followed by every 5 years after that (NCCN).

G. Resection

Colectomy can be performed either open or laparoscopically, depending on the level of experience of the surgeon, and should include a formal lymphadenectomy, including the identification of lymph nodes at the origin of the feeding vessel. Any suspicious node seen during surgery outside of the resection margins should be removed and sent to pathology as well. The requirements for N staging consist of the identification of a minimum of 12 lymph nodes in order to be considered a complete and adequate resection (NCCN).

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63 Colonic Conditions: Adenomatous Polyps

Steven A. Lee-Kong and P. Ravi Kiran

Refer to Algorithm in Fig. 63.1

A. The association between colorectal adenomatous polyps and colorectal cancers (CRC) was first described by Lockhart-Mummery and Dukes in 1927. This association set the stage for the later recognition that adenomatous tissue is a precursor to the development of CRC. The "adenoma to carcinoma" sequence was further elucidated by the identification of somatic mutations associated with this progression by Vogelstein et al. in 1988. These authors analyzed both colorectal adenomas of varying size and carcinomas for somatic mutations in known colorectal cancer-associated genes. Mutations in *ras* genes were more commonly identified in large adenomas and cancers as compared to smaller adenomas. In advanced adenomas and carcinomas, as compared to smaller adenomas, chromosomal sequences were also lost in chromosomal regions associated with cancer. These results helped to solidify our understanding of the step-wise development of colorectal cancer, involving both oncogene activation and loss of tumor suppressor gene activity.

B. The National Polyp Study, published in 1993, provided further evidence for the progression of adenomatous polyps to colorectal cancer. In this study, patients who underwent screening colonoscopy and polypectomy of histologically proven adenomatous polyps were compared to reference groups of patients for whom adenomatous polyps were not removed. The authors found that patients who underwent polypectomy had a lower-than-expected incidence of colorectal cancer when compared to the reference groups. This study underscored the importance of screening colonoscopy for the prevention of colorectal cancer.

C. Guidelines which suggest a colonoscopy screening algorithm are published by the National Comprehensive Cancer Network (NCCN), last updated in 2016. Initial screening for average risk individuals (no prior history of adenomatous polyp or colorectal cancer, no family history of colorectal cancer and no personal history of inflammatory bowel disease) should start at 50 years of age. Individuals with any of the above conditions should be screened based on NCCN guideline suggestions. Special consideration

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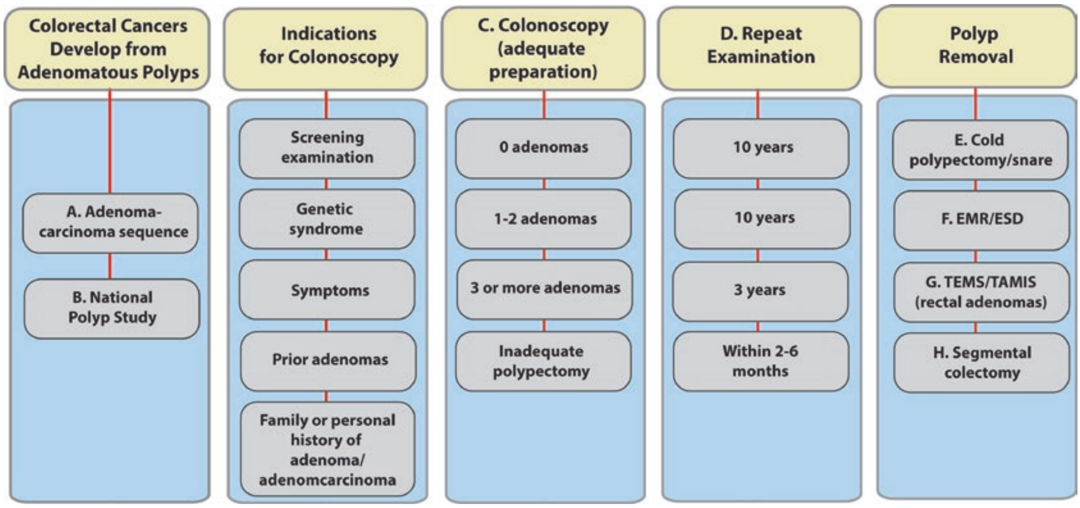

Fig. 63.1 Algorithm for colonic adenomatous polyps

should be given to individuals in whom a high-risk colorectal cancer syndrome may exist. These categories include Lynch Syndrome, Hereditary Nonpolyposis Colorectal Cancer (HNPCC), classical or attenuated Familial Adenomatous Polyposis syndrome (FAP or aFAP), MUTYH-associated polyposis (MAP), Peutz-Jeghers syndrome, Juvenile polyposis syndrome, Serrated polyposis syndrome, Cowden syndrome or Li-Fraumeni syndrome, who should be screened earlier. If an adenomatous polyp is found, complete removal should be performed. Intervals for repeat screening examinations depend on the presence and number of adenomatous polyps found on the index colonoscopy, polyp size and the presence of advanced adenomas (high-grade dysplasia, sessile serrated histology, villous or tubulovillous histology).

If no adenomatous polyps are found at the index colonoscopy, repeat examination is recommended in 10 years. Presence of 2 or fewer low-risk adenomatous polyps should prompt repeat examination in 5–10 years. Three or more adenomatous polyps, or presence of advanced adenomas, should prompt a repeat examination in 3 years. Incomplete or piecemeal polypectomy should prompt repeat examination within 6 months.

Patients with inflammatory bowel disease are recommended screening colonoscopy 8–10 years after the onset of symptoms. Ongoing surveillance depends on disease activity in addition to endoscopic findings. Individuals with a first degree relative with a colorectal cancer diagnosed at less than age 60 years should have their index examination at age 40, or 10 years earlier than the age of earliest CRC diagnosis in that first-degree relative. Individuals with a first-degree relative with an advanced adenoma should have their first colonoscopy at either age 50 or at the age of the family member with the advanced adenoma, whichever is earlier.

D. Even after appropriately timed screening colonoscopy, interval adenocarcinomas can occur in approximately 10.5% of patients. The majority of these interval lesions occur in the right colon. Theories as to the cause of this phenomenon include a worse bowel preparation in the right colon, biological differences in tumors of the right colon or an

increased proportion of flat lesions in the right colon that may have been missed at screening colonoscopy. Meticulous inspection behind mucosal folds and behind the ileocecal valve may help improve lesion detection.

E. During colonoscopy, polypectomy of small lesions (less than 3 mm in diameter) can usually be achieved by use of a cold biopsy forceps. The instrument is passed through the working channel of the colonoscope and the lesion excised, either in its entirety with one pass or in "piecemeal" fashion. For this purpose, the authors prefer using a "jumbo" size forceps, as the jaws can accommodate more tissue and help ensure a complete polypectomy. For larger polyps, biopsy forceps may not allow for complete polypectomy. In this situation, snare polypectomy may be necessary to ensure complete polyp excision. This device is similarly passed via the working channel of the endoscope. The snare is opened and secured around the base of the polyp. Complete closure of the device amputates the lesion. Once complete, the polyp can be grasped and withdrawn by aide of a through-the-scope net or suctioned through the colonoscope and captured in a specimen trap. Submucosal injection can also be utilized to aide in excision of the polyp. An injectate such as normal saline, glycerol, or hyaluronic acid is injected in the submucosal plane beneath and around the polyp, "lifting" the lesion off the muscularis propria. This can allow a snare to be deployed around the lesion, and may also minimize the possibility of transmural injury to the bowel, particularly if cautery is used. There is no consensus as to which injectate provides the best results. Polyps that do not lift appropriately during injection may indicate an invasive lesion, and complete polypectomy may not be possible. Prior attempts at polypectomy may also cause scarring within the lesion, precluding adequate lifting. For snare polypectomy, it is often helpful to position the lesion at the "5 o'clock" position on the screen, as this is where the working channel port is. This should allow proper positioning of the snare.

F. Advances in flexible endoscope technology and equipment have provided the opportunity to improve adenoma detection rates. Advanced techniques are now available to safely remove adenomas, both small and large. In years past, patients discovered to have large adenomas considered too large to remove endoscopically were referred for surgical resection. Advanced endoscopic techniques, including endoscopic mucosal resection (EMR) and endoscopic submucosal dissection (ESD), have given endoscopists the opportunity to offer patients a minimally invasive approach to remove difficult colorectal polyps. While both techniques can be useful in avoiding major surgical resection for pre-malignant lesions, there are some key differences between the two. EMR is widely accepted for the resection of larger adenomatous polyps, however, larger lesions can be difficult to remove completely [9]. ESD can be used to improve completeness of resection (R0) and thereby decrease recurrence rates. A recent meta-analysis comparing EMR to ESD utilized data from 6 trials and pooled evaluation of 1642 adenomatous polyps. ESD was associated with higher en bloc resection and lower local recurrence. The complication rates were similar, however, ESD was more time consuming.

G. Advanced trans-anal approaches are also available for patients with large rectal polyps. Transanal endoscopic microsurgery (TEMS) and transanal minimally invasive surgery (TAMIS) techniques have become more widespread and can allow for safe removal of accessible lesions. In a recent meta-analysis comparing TEMS to conventional transanal excision, TEMS was associated with a higher rate of negative margins, less specimen fragmentation and lower recurrence rates, with no difference in overall complications. Recently, TAMIS has grown in popularity since its initial description in 2010 by Atallah et al. While high quality data are still lacking, TAMIS has

also shown promising results, comparable to TEMS [14] in terms of achieving negative margins and minimizing polyp recurrence.

H. Surgical resection of the colon or rectum for endoscopically unresectable adenomatous polyps, outside of transanal approaches, usually requires partial colectomy. Patients deemed appropriate surgical candidates are offered abdominal surgery, which can be done in traditional open fashion or by utilizing minimally invasive techniques. In general, traditional oncologic principles are followed during the resection, as larger adenomatous polyps can harbor invasive cancer. Some series report that for larger polyps between 1.5 cm and 3.5 cm in diameter, the risk of harboring an invasive cancer can range from 19 to 43%. Ensuring adequate lymphadenectomy in this setting is important for cancer staging.

I. Cancer within a polyp: Endoscopic vs surgical resection.

Adenomatous polyps with foci of invasive cancer can be a management dilemma. The risk of lymphatic spread is directly correlated with the T-stage of the lesion. For pedunculated or sessile adenomatous polyps identified at colonoscopy, endoscopic resection can be entertained, if deemed appropriate by the endoscopist. Patients with pedunculated adenomatous polyps with foci of invasive cancer excised in 1 piece with clear margins, confirmed to be T1 in depth and with favorable histologic features (well or moderately differentiated, absent lymphovascular invasion) can safely observed without resection. For sessile lesions with the same above features, both observation and radial resection can be considered appropriate treatment.

The Haggitt Classification system for pedunculated polyps with foci of invasive cancer is useful to describe the level of invasion into the submucosa. Haggitt level 1 lesions have the component of adenocarcinoma limited to the head of the polyp. Level 2 lesions have the adenocarcinoma extend to the neck of the polyp. Level 3 lesions have cancer extension to the stalk of the polyp, and in level 4 lesions extend beyond the stalk, but still limited to the submucosa. Haggitt levels 1–3 are associated with a very low rate of lymph node metastasis, and these lesions can be safely managed with endoscopic polypectomy.

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64 Colon Cancer Surgical Therapy

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Refer to Algorithm in Fig. 64.1

A. The colon occupies portions of the retroperitoneal and intraperitoneal abdominal spaces, in close proximity to multiple solid organs and the small bowel. The ascending and descending colon are retroperitoneal, while the transverse colon is intraperitoneal. The sigmoid colon ends where the taenia converge to form the rectum.

B. The entire right colon to the junction of the middle and distal third of the transverse colon are supplied by the right colic and the ileo-colic arteries (Fig. 64.2), which are branches of the superior mesenteric artery. The middle colic artery supplies the majority of the transverse colon. The arterial supply of the distal transverse and left colon down to the lower rectum are supplied by the left colic and sigmoid arteries which are branches of the inferior mesenteric artery. These branches anastomose with the left branch of the middle colic artery to form part of the marginal artery of Drummond. The marginal artery of Drummond and the arc of Riolan provide the collateral blood circulation and typically the blood supply of the transverse colon is excellent, as long as the marginal artery is not damaged. Variability in the arterial anastomoses occurs, which is an important point when performing a segmental resection. The two most tenuous sites, "watershed areas", are the splenic flexure (Griffith's point) and the distal descending colon (Sudeck's point). The venous and lymphatic drainage of the colon tends to parallel the arterial supply (Figs. 64.3 and 64.4). For the right and left colon, the venous drainage is through the superior and inferior mesenteric veins, respectively.

C. The extent of resection is based on the blood supply that drains the tumor-bearing segment of the colon. It is recommended that the proximal and distal margins are a minimum of 5 cm. The mesentery of the affected segment should be removed *en bloc* with the major feeding vessel(s) and the dependent lymphatic drainage. Any malignant-appearing lymph nodes (LNs) outside the boundaries of the resection should also be removed if possible. Standard ligation of the feeding vessel at the origin is recommended by the American Society of Colon and Rectal Surgeons (ASCRS). Furthermore, one large study suggests a higher overall survival and lower recurrence rate when high vascular ligation is performed for Stages II and III (i.e., Dukes B and C) colorectal tumors. A minimum of 12 LNs should be identified and evaluated from the resected colon cancer

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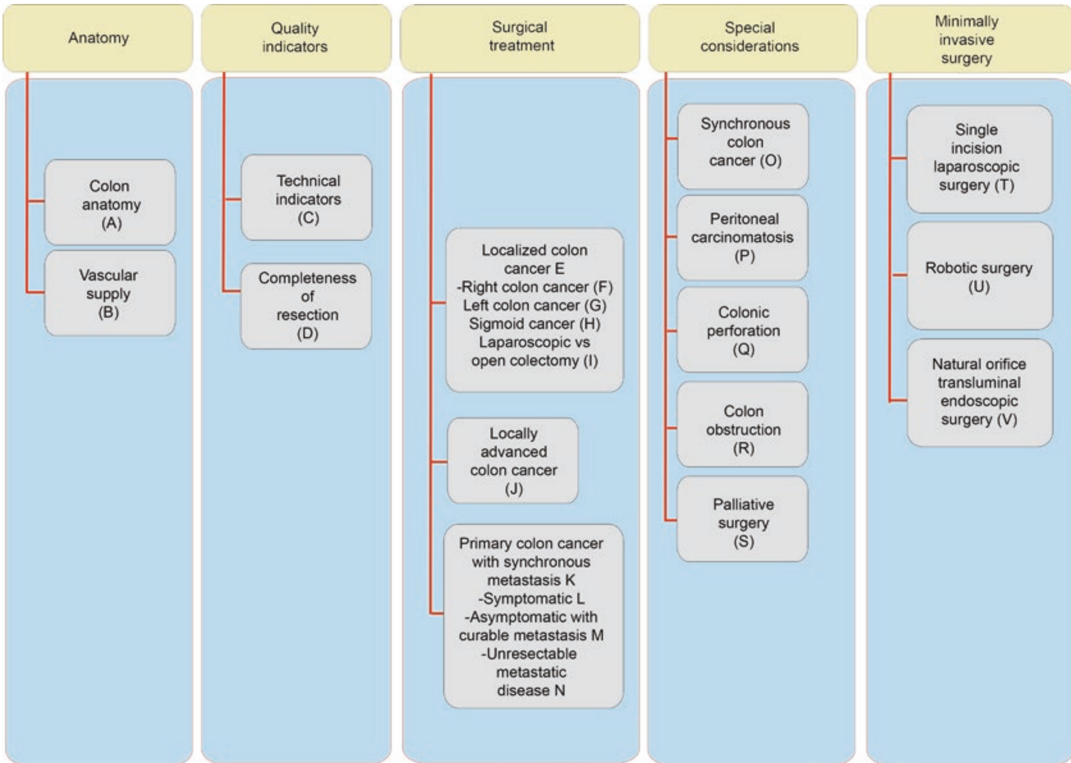

Fig. 64.1 Algorithm for surgical treatment of colon cancer

specimen to allow accurate staging. The College of American Pathologists suggests that if fewer than 12 LNs are initially identified, additional evaluation should be performed on the specimen to localize more nodes. Patients with N0 disease but fewer than 12 LNs examined are considered higher-risk Stage II disease and should be considered for adjuvant chemotherapy. The complete surgical removal of the regional mesocolic lymph nodes allows for a curative resection and accurate pathologic staging of the disease. When suspected to be involved, the most apical lymph nodes should be marked on the specimen as their metastatic involvement is a negative prognostic indicator. The technique of complete mesocolic excision with central vascular ligation is an approach used to resect the colon and its lymphovascular supply by removing the colon and mesocolon together with an intact envelope of visceral peritoneum similar to the concept of total mesorectal excision for rectal cancer. The approach depends on dissecting the visceral plane from the parietal one and dividing feeding arteries centrally at the origin of the vessels resulting in an increase lymph node harvest and resection of more mesocolic tissue. The increased lymph node yield may allow for stage migration but improved outcomes have not been confirmed with any randomized trials.

D. Colon cancer staging should be performed according to the American Joint Committee on Cancer (AJCC)/TNM system where the tumor depth, nodal metastasis, and distant metastasis are an important predictors of prognosis in colon cancer (Tables 64.1 and 64.2). Histologic grade has also been shown to be an important predictor of outcome and is usually an important consideration for treatment recommendations. Completeness of the surgical resection should be assessed and is designated by the residual tumor code “R.”

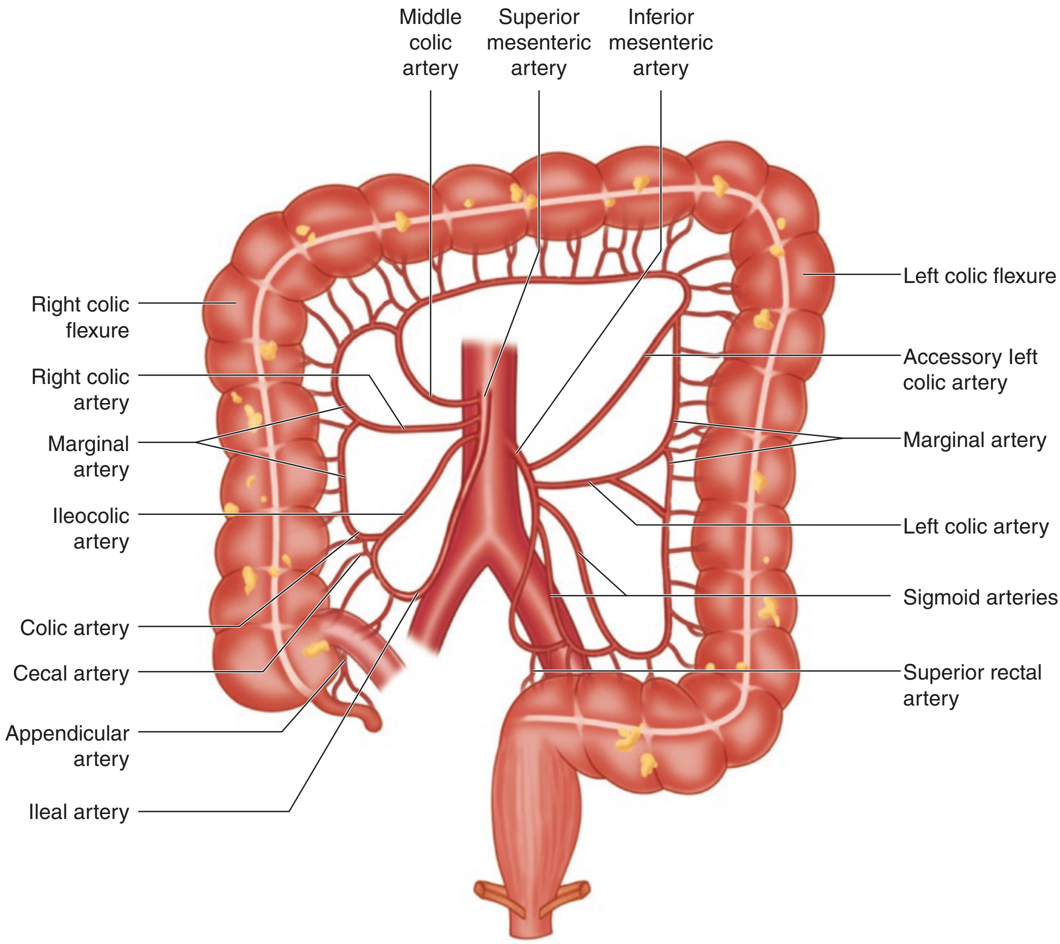

Fig. 64.2 Arterial Supply of the colon

- R0—complete tumor resection with all margins histologically negative.
- R1—incomplete tumor resection with microscopic surgical resection margins involvement (margins grossly uninvolved).
- R2—incomplete tumor resection with gross residual tumor that was not resected (primary tumor, regional nodes, macroscopic margin involvement).

E. The primary treatment for localized colon cancer is colectomy with *en bloc* mesocolic excision to include all associated regional lymph nodes (Fig. 64.5). A thorough abdominal exploration is essential, including assessment of the peritoneal cavity and the abdominal organs to exclude any synchronous lesions, more advanced malignant disease such as carcinomatosis, adjacent organ involvement, or occult metastasis, or co-existing pathology including adhesions, hernia, cholelithiasis, or cirrhosis. The value of the "no touch" technique, in which the vascular supply to and from the tumor are divided before manipulating the tumor, is still controversial, and definite benefit has not been demonstrated. Yet, gentle handling of the tumor during operation should be adopted to avoid the risk for tumor spillage or perforation, and in particular with locally advanced tumors or those with associated abscess. Resection should be performed *en bloc* with preservation of the integrity of the colonic mesentery. The complete surgical removal of the regional mesocolic lymph nodes allows

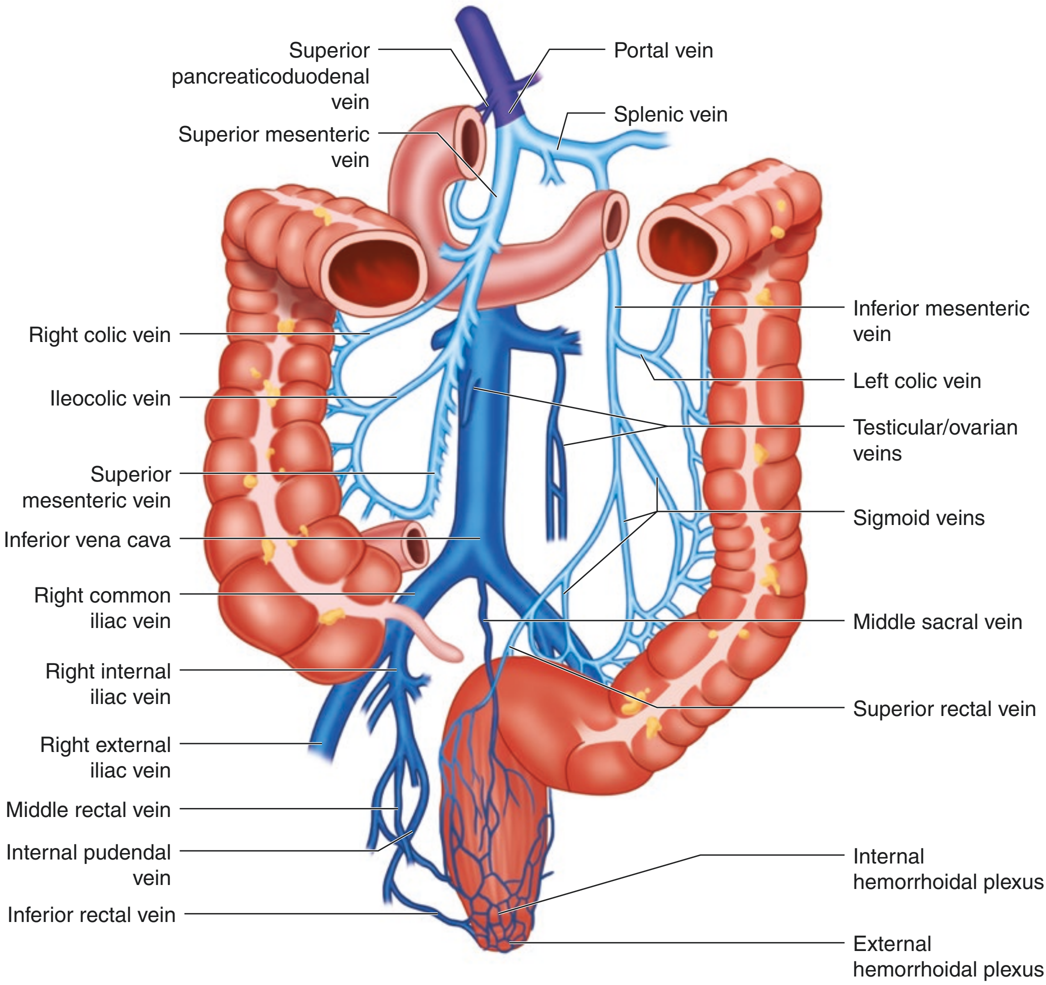

Fig. 64.3 Venous supply of the colon

for a curative resection and accurate pathologic staging of the disease. Clinically positive lymph nodes located outside the standard field of resection and suspected to contain metastatic disease should be biopsied or removed at the time of the primary resection. If residual tumor-bearing lymph nodes remain following sampling, the resection is considered incomplete. High ligation, which is defined as dividing the feeding vessel as close as possible to its origin-- usually within 1 cm from the origin, allows for a more complete lymphadenectomy and gains in the proximal colon length. High ligation technique has not been shown to improve survival in comparison to low ligation, especially in the absence of clinical evidence for metastasis to this extended lymph node distribution. Therefore, the optimal level of ligation should be determined by the feasibility of performing a tension-free anastomosis with a well vascularized proximal colon. Omental resection should be performed to include the portion of omentum attached to the resected portion of the colon.

F. A right hemi-colectomy (Fig. 64.5a) is usually performed for cancer of the cecum and ascending colon. The resection extends from

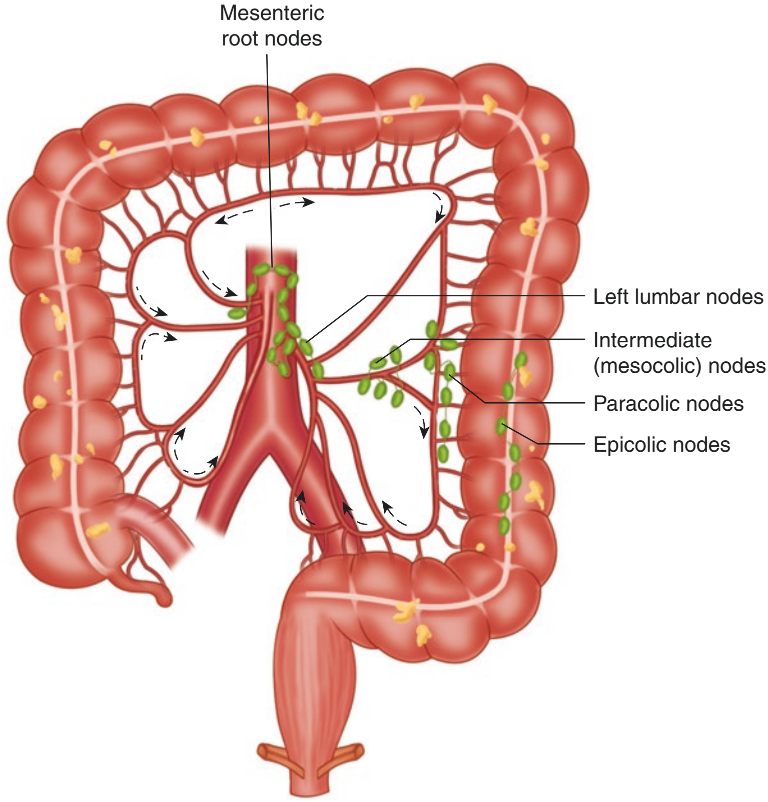

Fig. 64.4 Lymphatic drainage of the colon

the distal ileum and can extend to the mid-transverse colon. This involves isolating and dividing the ileocolic, right colic and either the right or hepatic branch of the middle colic artery and vein. A right extended colectomy is indicated for malignant lesions located at the hepatic flexure or proximal to mid-transverse colon (Fig. 64.5b). It includes resection of the distal transverse colon and sometimes the splenic flexure, and involves ligating the ileocolic, right colic, and middle colic vessels. There are two approaches to mobilizing the colon. The first begins laterally and progresses medially, where the mesentery is mobilized prior to vascular division. This allows for accurate identification of the root of the mesentery, the retroperitoneal duodenum, and the right ureter prior to division of the vessels. The second is the medial-to-lateral technique which begins medially by identifying the lymphovascular bundle and progresses laterally. The latter has been used primarily in laparoscopic surgery where vascular ligation prior to mobilization optimizes traction and exposure of the mesenteric structures. However, this approach can be used in the open settings as well. The best approach depends on the surgeon's experience and preference. For restoring bowel continuity, the anastomosis can be completed as a side-to-side or end-to-side ileocolic anastomosis and can be fashioned either using a stapler device or hand-sewn technique. Experience, surgeon's preference, and availability of equipment dictate the suitable technique. A stapled anastomosis is faster and offers the potential for reduced fecal contamination. However, there are no significant differences between stapled and hand-sewn anastomoses when comparing outcomes including mortality, anastomotic leaks, hemorrhage, and wound infection. A meta-analysis of nine randomized trials that included 1233 adults undergoing elective colorectal surgery found

Table 64.1 TNM classification and AJCC 8th edition staging of Colon Cancer

Primary tumor staging (T)	
T0	No evidence of primary tumor
Tis	Carcinoma in sit, intramucosal carcinoma
T1	Tumor invades submucosa
T2	Tumor invades muscularis propria
T3	Tumor invades the muscularis propria into the pericolic tissue
T4a	Tumor penetrates to the serosa (visceral peritoneum)
T4b	Tumor invades or is adherent to other organs or structures
Regional lymph node staging (N)	
N0	No regional LN metastasis
N1a	Metastasis into 1 regional LN
N1b	Metastasis into 2–3 regional LNS
N1c	Tumor deposits in subserosa, mesentery, or non-peritonealized pericolic or perirectal tissues without regional nodal metastasis
N2a	Metastasis into 4–6 regional LNS
N2b	Metastasis into 7 or more regional LNS
Distant metastasis staging (M)	
M0	No distant metastasis
M1a	Metastasis confined to 1 organ or site
M1b	Metastasis in more than 1 organ
M1c	Metastasis to the peritoneum with or without other organ involvement

Table 64.2 AJCC staging – American Joint Committee on Cancer

Stage	T	N	M
0	Tis	N0	M0
I	T1–2	N0	M0
IIA	T3	N0	M0
IIB	T4a	N0	M0
IIC	T4b	N0	M0
IIIA	T1-T2	N1-N1c	M0
	T1	N2a	M0
IIIB	T3-T4a	N1-N1c	M0
	T2-T3	N2a	M0
	T1-T2	N2b	M0
IIIC	T4a	N2a	M0
	T3-T4a	N2b	M0
	T4b	N1-N2	M0
IVA	Any T	Any N	M1a
IVB	Any T	Any N	M1b
IVC	Any T	Any N	M1c

insufficient evidence to demonstrate the superiority of stapled over hand-sewn anastomosis. However, the stricture rate was higher for stapled versus hand-sewn anastomosis (8% vs. 2%, respectively). Hand-sewn technique is often preferred when the bowel is very thick or distended.

G. Left hemi-colectomy, is the procedure of choice for tumors of the splenic flexure and descending colon. Resection extends from the distal transverse colon to the sigmoid colon or upper rectum, ~2–3 cm above the sacral promontory (Fig. 64.5c–e). Vessels ligated during resection include the pedicle of the left colic artery and the first sigmoid branch. The anastomosis is usually intraperitoneal. The left colon can be mobilized either from lateral-to-medial or medial-to-lateral fashion. The splenic flexure should be mobilized cautiously to avoid injury to the spleen. During left-sided colon resections, it is critical to identify the ureter, preferably prior to transecting the colon. Restoring bowel continuity either by stapled or hand-sewn end-to-end or side-to-end colocolic or colorectal anastomosis. The anastomosis can be tested for leaks by submerging the anastomosis in fluid and injecting air via a rigid or a flexible endoscope. The staple line is inverted with nonabsorbable sutures if a leak is identified and the assessment process is repeated until no leak is identified. Conversely the anastomosis may be taken down and redone. Fecal diversion should be considered in cases where the integrity of the anastomosis is of concern to the surgeon.

H. In sigmoid colon cancer, sigmoid colectomy is appropriate (Fig. 64.5f). The inferior mesenteric artery is divided at its origin, and dissection proceeds just under the superior rectal vessels toward the pelvis until adequate margins are obtained.

I. Laparoscopic and open colectomy achieve equivalent oncological outcomes for localized colon cancer. The use of the laparoscopic approach should be based on the surgeon's experience in advanced laparoscopic surgery as well as patient and tumor-specific factors. A number of large multi-institutional randomized trials in the United States and internationally have demonstrated equivalent overall and recurrence-free survival rates

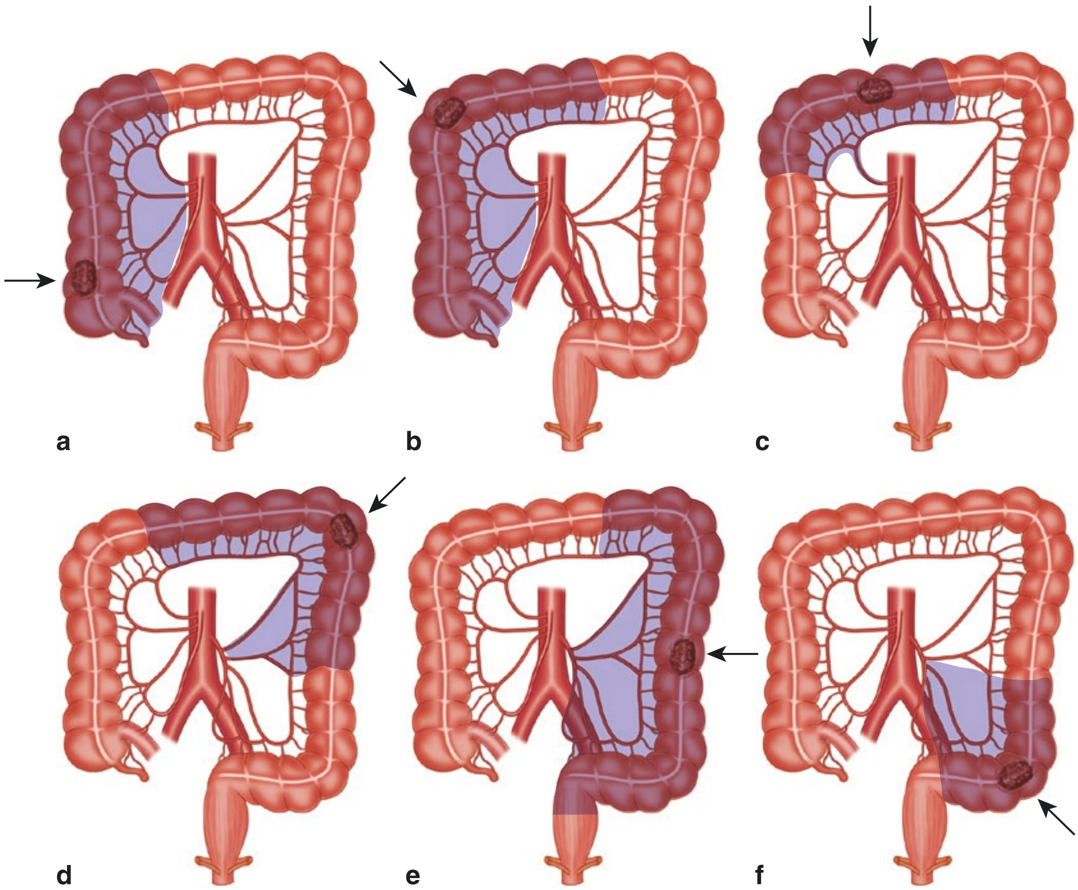

Fig. 64.5 Types of Colon resections. (**a**) Right Hemi-colectomy; (**b**) Extended Right Hemi-colectomy; (**c** and **d**) Left Hemi-colectomy; (**e**) Left colectomy for splenic flexure tumor; (f) Sigmoid resection

after laparoscopic versus open surgical resection of localized colon cancer, excluding tumors within the rectum or transverse colon. Laparoscopic colectomy has improved short-term outcomes including shorter hospital stay, decreased pain, less scarring, and earlier return to baseline activities. Therefore, minimally invasive colectomy is being performed with increasing frequency and may be the preferred approach if done by a surgeon experienced in this technique. This supports the American Society of Colon and Rectal Surgeons position statement regarding credentialing of surgeons to perform laparoscopic colectomy for cancer.

J. Approximately 10% of patients with colon cancer have invasion into contiguous organs or inflammatory adhesions involving neighboring structures. Preoperative imaging using computed tomography (CT) scan or magnetic resonance imaging (MRI) usually facilitates the identification of adjacent organ involvement prior to surgical exploration, so that adequate preparation and assembly of a multidisciplinary team can be arranged. Intra-operatively, it is usually not possible to distinguish between inflammatory and malignant adhesions. In more than 40% of cases the peri-tumoral adhesions have been shown to harbor malignant cells. Therefore, the best treatment is complete resection of the tumor *en bloc* with adjacent involved structures and avoiding division of peri-tumoral adhesions if possible. The key to the resection is obtaining a negative margin and removing an adequate lymph node sample. When this is not feasible, then neoadjuvant or adjuvant therapy with radiation

and/or chemotherapy can be utilized to improve the oncologic outcomes.

K. Approximately 15–20% of patients will present with liver or lung metastases at the time of initial presentation with colon cancer. About 20–25% of these patients will have potentially resectable disease. The treatment of patients presenting with synchronous Stage IV disease should be individualized and guided by a multidisciplinary team including disease-specific surgeons (*i.e.,* colorectal, hepatic and/or thoracic surgeons), radiologists, and medical oncologists. Patients may be classified as initially having clearly resectable disease, potentially resectable disease, or unresectable disease with respect to both their primary tumor site and metastases. There are various approaches to initial management of the primary site in patients who present with Stage IV disease. These include upfront resection of the primary tumor and/or metastases or neoadjuvant chemotherapy followed by resection if feasible. There is no strong data favoring either approach and decision is usually based on institutional preferences. In general, the decision for sequence of treatment must take into account the presence or absence of symptoms from the primary tumor and whether the metastases are resectable or not at presentation.

L. A patient with a symptomatic primary tumor (*e.g.*, bleeding, obstruction, perforation) in the setting of synchronous potentially resectable solid organ metastatic disease should undergo resection of the primary tumor upfront. If the patient has limited or easily resectable metastatic disease then a one-stage combined resection can be performed. However, if metastasectomy would considerably impact the risk of complications, then only the primary tumor should be resected initially followed by chemotherapy and then metastatic re-evaluation for resection. For symptomatic patients who are not candidates for resection of the primary tumor, palliative options can be considered. These include endoluminal stenting, surgical bypass, diverting ostomy, or laser ablation for non-obstructing tumors.

M. In asymptomatic primary colon cancer, the decision depends on whether the metastatic disease can be cured or not. If the metastases are potentially resectable for cure, then an aggressive surgical approach is warranted for both the primary and metastatic sites with the aim of curing the patient. Previously the number of hepatic metastases was an important criterion in determining resectability. However, in the modern era, tumor location and residual liver volume are the most useful tools. Metastatic tumors that are bilobar or that are borderline resectable due to location may be better managed with upfront chemotherapy followed by reassessment for delayed resection. Delayed metastatic resection does not increase the risk of becoming unresectable due to growth. However, chemotherapy negatively affects the quality of the liver parenchyma and can cause chemotherapy-associated steatohepatitis (CASH). This may require a larger future liver remnant to maintain adequate hepatic function and reduce postoperative complications. Treatment must be individualized with a multi-disciplinary approach. Most commonly systemic chemotherapy is administered to attempt to shrink metastatic disease so that it becomes more clearly resectable. Furthermore, progression of disease on chemotherapy may indicate aggressive biology of the tumor. Survival rates after resection of colorectal carcinoma with liver metastases are better in patients who experience an objective response to chemotherapy. Other potential treatments include combination of resection and ablation of metastases, staged resection (either primary or metastases first) with chemotherapy used between resections, hepatic artery infusion pump therapy, and preoperative portal vein embolization to increase size of future liver remnant if residual liver volume is the main concern. One of the points of debate is whether surgical excision of the primary tumor and metastasis should be carried out simultaneously or colorectal resection first followed by hepatectomy or hepatectomy first followed by resection of the primary tumor. For most patients, simultaneous

resection of the primary and metastatic disease is clearly preferable from the patient's perspective, and several case series and meta-analyses have shown equivalent survival and morbidity for patients who undergo a single-stage procedure compared with delayed (staged) hepatic resection, unless major hepatic resection (three or more segments) is needed. Factors that influence the decision for single-stage surgery versus a staged approach include the anticipated complexity of the colectomy and hepatectomy, the size of the future liver remnant, the likelihood of major blood loss or prolonged hepatic ischemic times, and patient comorbidities. Surgery provides a potentially curative option for selected patients who present with limited metastatic colorectal cancer (CRC). If the metastases are potentially resectable, especially if they are located in one organ system (such as liver or lung), both the primary and the metastases should be managed aggressively. With the combination of surgery and chemotherapy, long-term survival can be achieved in as many as 50% of cases.

N. The use of modern chemotherapy without resection of the primary tumor for unresectable metastatic disease is also debated. These patients can benefit from palliative surgery to relieve the symptoms of obstruction and bleeding from the primary tumor. However, many of these patients are completely asymptomatic or have minimal symptoms. With systemic therapy, the current median survival among patients with unresectable metastatic colon cancer is currently greater than 24 months and may be as long as 34 months. Previous studies had evaluated the role of primary resection in patients with stage IV disease and demonstrated an association with improved survival. However, these observational studies are limited by significant selection bias and outdated chemotherapy regimens. Presently, more studies favor starting chemotherapy without resecting the primary tumor. This approach may reduce potential delays in starting chemotherapy from surgical morbidity since the risk of developing a complication from the primary tumor is low where obstruction develops in <15%, hemorrhage in <5% and peritonitis or fistula <7%. Therefore, in the setting of unresectable metastatic disease, it is preferable to only selectively resect the primary tumor if symptoms are present.

O. In recent years, the synchronous primary colorectal cancers have been estimated to occur in 2% to 5% of all patients diagnosed with primary colorectal cancer. The management of synchronous colon cancers is still debated widely and often depends on the surgeon's preferences. Surgical options include multiple segmental resections or subtotal colectomy. Patients with synchronous tumors should be evaluated for an associated genetic colorectal cancer syndrome or other underlying colonic disease (*e.g.*, hereditary non-polyposis colorectal cancer syndrome or chronic ulcerative colitis). This may influence surgical decision making in terms of extent of resection to ensure optimal treatment of the underlying disorder.

P. The incidence of peritoneal carcinomatosis is estimated at about 5–10% of colorectal cancer cases. Until recently, peritoneal carcinomatosis from colon cancer was considered incurable metastatic disease. However, multiple studies suggest a benefit to cytoreduction surgery and hyperthermic intraperitoneal chemotherapy (HIPEC). The main prognostic factors are the initial extent and location of the disease in the abdominal cavity during exploration, this is reflected by the peritoneal carcinoma index (PCI) score and also the completeness of cytoreduction. A consensus statement in 2006 on peritoneal surface malignancies of colonic origin indicated that better patient selection and surgical techniques to achieve complete cytoreduction have resulted in improved survival (median survival up to 42 months) and decreased morbidity in this group of patients.

Q. Treatment options in patients with tumor perforation depend upon the patient's overall condition and whether peritonitis is localized or generalized. If the patient is stable and peritonitis is localized, tumor resection with

primary anastomosis can be performed in those who are good surgical candidates. Primary anastomosis is not typically performed in the clinical setting of diffuse peritonitis or free perforation, and/or in medically unstable patients. For patients with a localized fluid collection or abscess, percutaneous drainage can be performed. However, if transabdominal drainage is performed, there is a potential for seeding of the drain tract, and therefore, at the time of definitive resection, the drain tract should be resected. Similarly, perforation may cause the tumor to adhere to other organs and an en bloc resection may be necessary.

R. The management of patients with an obstructing cancer should be individualized depending on the site of obstruction and the presence of proximal colonic distention with fecal load. Options for treatment may include resection with or without anastomosis (*e.g.*, Hartmann resection), resection of the distended bowel (*e.g.*, subtotal/total colectomy), or relief of the obstruction and fecal load (*e.g.*, endoluminal stenting or colostomy). The prognosis among patients with obstructing cancers may be worse in comparison to those without obstruction because of the inherently more advanced nature of their disease. However, this does not preclude the potential for curative resection. For tumors of the right or transverse colon, a tumor-directed resection removes the distended colonic segment, and an enterocolonic anastomosis can generally be safely achieved due to low bacterial counts in the right and transverse colon taking into consideration the patient's general condition at the time of resection and the absence of other factors that indicate the need for a protective stoma. During curative resection, the principles of oncological resection should be adopted. A variety of surgical options exist for patients who present with a left-sided colon obstruction from cancer. Appropriate surgical approaches include resection with end colostomy and rectal pouch (*i.e.,* Hartmann's procedure), resection with primary anastomosis, and subtotal colectomy with ileorectal anastomosis. In a retrospective study of 243 consecutive patients who underwent emergent surgery for obstructing colon cancer at Queen Mary's Hospital in Hong Kong, there was no statistically significant difference in hospital mortality or anastomotic leak rates among patients who underwent resection and primary anastomosis regardless of tumor location (right- versus left-sided). Nevertheless, many surgeons routinely perform a temporary proximal diverting colostomy following resection of an obstructing left-sided colon cancer. If a primary anastomosis is performed, it should be studied for integrity and patency prior to closure of the stoma. If the entire colon was not evaluated prior to the stoma formation due to the emergent situation or due to an obstructing tumor, colonoscopy is indicated prior to ostomy closure. In selected patients, successful preoperative stenting may allow for colonic decompression, metabolic and nutritional recovery, and adequate workup (operability, colonic evaluation) to optimize subsequent elective resection. A randomized trial of palliative stenting versus surgery was prematurely closed owing to an unexpectedly high rate of perforations in the stented group so patients should be carefully selected. The selection of the surgical approach should consider the patient's general condition at the time of resection as well as the quality of the proximal bowel. The morbidity and mortality of a segmental resection, following intraoperative colonic irrigation, among patients with left colonic malignant obstruction has been compared with subtotal colectomy and has not been shown to be superior. Other recent studies have demonstrated that colonic irrigation may not be mandatory before primary bowel anastomosis in this setting. For patients who are not good candidates for surgery, a temporizing approach for an obstructing cancer is endoscopic placement of an expandable metal stent. Endoluminal stenting in the setting of an obstructing colon cancer can also be used as a bridge to prepare the colon

before proceeding with resection and primary anastomosis.

S. The methods for surgical palliation for patients with symptomatic colon or rectal cancer with incurable metastatic disease include:
   - Resection of primary cancer and primary anastomosis
   - Diverting stoma
   - Bypass procedure

   For patients who can tolerate an intra-abdominal procedure, the optimal palliative procedure is resection with primary anastomosis. However, resection or primary anastomosis may not be feasible because of extensive local disease that may involve adjacent structures, or serious comorbid conditions. In these cases, a diverting colostomy is the procedure of choice, especially in patients with distal colonic tumors. A loop colostomy can be used, however, an end colostomy is preferred because it is easier to manage and has fewer long-term complications. For patients with unresectable obstructing cancers, a bypass between the small bowel and the colon distal to the obstruction can be performed. However, if the patient has a competent ileocecal valve, there is potential for distention of the bypassed segment and eventual development of closed loop obstruction due to the accumulation of secretions in the bypassed colon. In these cases, the cecum can be fixed to the abdominal wall with seromuscular sutures, and surgical clips can be placed in the abdominal wall to mark the area where a potential cecostomy tube can be placed at a later time if necessary. Regardless of the method of surgical palliation, the laparoscopic approach is preferred to minimize the risk of postoperative complications. Randomized trials in that setting have shown equivalent cancer outcomes and lower morbidity with the laparoscopic approach.

T. After the successful development of laparoscopic surgery for the treatment of colorectal diseases over the past two decades, newer techniques have evolved to try to further improve outcomes. Single Incision Laparoscopic Surgery (SILS), is a technique that utilizes a unique port, usually placed near the umbilicus or at the site of the future stoma. Multiple instruments and a scope can be introduced through this port to perform the procedure. This approach is primarily intended to minimise the potential risks of trocar-related complications, to improve cosmetic results, and to reduce the inflammatory response to surgical trauma. This approach is suitable in patients with low BMI and small-sized tumours. Data regarding long-term oncological results for malignant disease is not available due to the lack of long-term follow-up studies.

U. Robotics were applied to surgery in the 1970s in the military setting and the first robot used in an operating room was designed in 1985. This newer approach provides a three-dimensional image, diminishes surgeon tremor, increases dexterity and ambidextrous capability, and is associated with a shorter learning curve. All these advantages are particularly useful in operations performed in small fields in which high precision is crucial such as pelvic procedures. However, despite the growing number of published articles on this topic there is lack of evidence about long-term oncological safety or its clinical benefits over conventional laparoscopy. Moreover this technique is expensive, which is a major drawback to the widespread adoption of robotic surgery. One of the most important disadvantages of robotic colon surgery is that the procedure is performed in multiple quadrants. With robotic surgery this may require repositioning of the robotic arms and thus increase the operative time. The initial case series reported the most benefit of robotic surgery during specific steps of the procedure, such as take down of the splenic flexure, lymphadenectomy or completing a hand sewn intracorporeal anastomosis. Still, there are major drawbacks related to robotics including the higher cost and longer operative times. In a randomised controlled trial with right-sided colonic cancer patients

undergoing right hemicolectomy, the duration of surgery was longer and the overall cost greater in the robotic group compared with the conventional laparoscopic group. In summary, robotic colorectal surgery is a safe and feasible technique but is associated with higher costs and longer operative times. The long-term oncologic results in patients with colon cancer are still to be determined.

V. Natural orifice transluminal endoscopic surgery (NOTES) appeared as a further progression of the laparoscopic approach without abdominal scars. It proposes the access to the peritoneal cavity with flexible endoscopic or rigid laparoscopic instruments using natural orifices such as the mouth (transgastric), the urethra (transvesical), the vagina (transvaginal) and the anus (transanal). Theoretically, NOTES offers a reduction in pain and wound-related complications as it is also defined as "scarless" surgery. In the field of colorectal surgery, transanal NOTES has been accepted as a hybrid procedure assisted by laparoscopy, and as a pure access to resect a rectal or colonic specimen. Recently, The German NOTES registry analysed its first 139 colonic NOTES procedures showing that transvaginal or transrectal NOTES colectomy is feasible and can be performed safely.

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65 Colonic Conditions: Locally Advanced Colon Cancer

Najjia N. Mahmoud

Refer to Algorithm in Fig. 65.1

A. Locally advanced colon cancers are defined as those that are T4a or T4b. According to the American Joint Committee on Cancer Eighth Edition staging guidelines, T4a cancers involve penetration to the surface of the visceral peritoneum whereas T4b tumors include those that directly invade or are adherent to other organs or visceral structures. Those tumors designated T4a are typically those that reside on intraperitoneal aspects of the colon like the transverse or sigmoid colon. The intraperitoneal colon is lined by serosa—those tumors that penetrate through the serosa are designated T4a and thought to have a poorer prognosis because of their hypothetical ability to promote intraperitoneal spread. In contrast, the definition of a T3 tumor is one that invades through the muscularis propria into the subserosa. A T4a tumor on the right colon can exist anteriorly, but not on the retroperitonealized surface lacking visceral serosa. A T4b tumor grossly extends to surrounding structures and is fairly easily recognizable at operation. Prognosis for node negative locally advanced colon cancers (Stage IIB/C) is worse than T3 node positive tumors (Stage III), making T4 designation a poor prognostic feature for Stage II disease and mandating consideration of additional medical therapy. For example, five-year survival rates for Stage IIB, and Stage IIC are 63%, and 55% respectively, compared to that of Stage IIIA which is 89%. The reasons are not clear, however, differential lymph node harvest, compromised margins, differential rates of referral for chemotherapy, and more aggressive biology have all been implicated (Table 65.1).

B. Locally advanced colon tumors have changed designation in the AJCC Eighth Edition. The revised staging gives more importance to the poor prognostic features of depth of invasion in spite of fewer positive nodes. T4 is divided between penetration to surface of visceral peritoneum and direct gross adherence to adjacent structures as mentioned previously. Locally advanced tumors (Stage II/IIIC) that penetrate into other structures represent only approximately 7% of colon cancers. Stage IIB (T4a) tumors represent 27% and Stage IIIA tumors 66%. It is not clear how much worse the prognosis is between Stage IIB and C tumors, but those tumors that invade adjacent organs are thought to confer a higher risk (Table 65.2).

C. Patients with locally advanced colon cancers typically present with anemia, obstruction,

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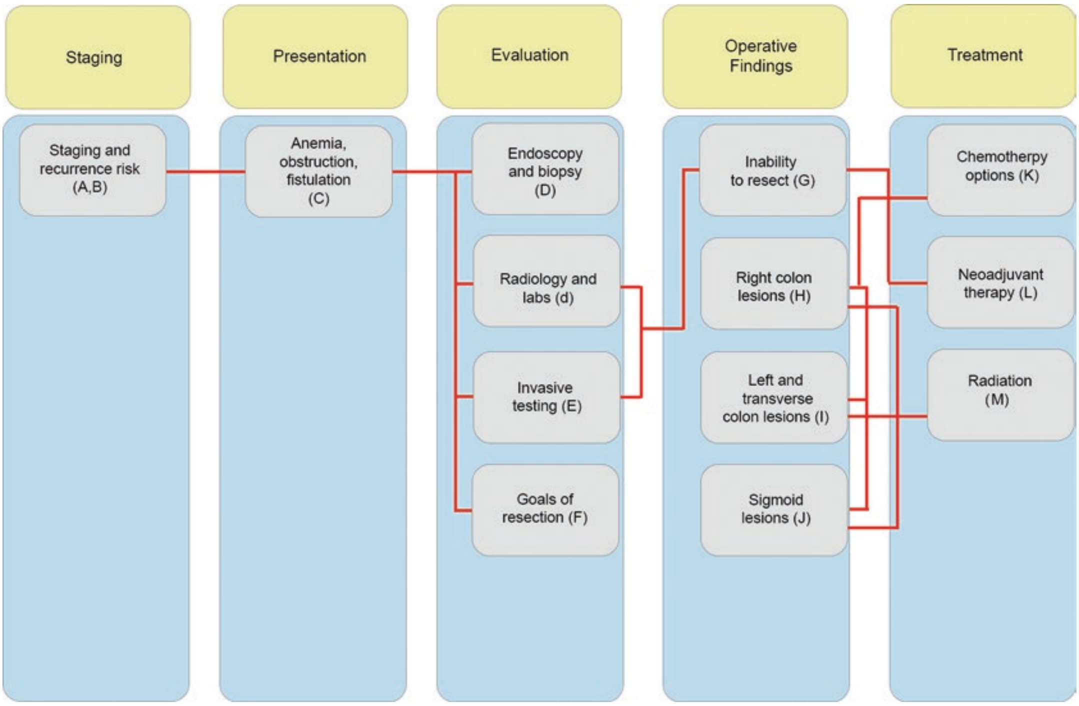

Fig. 65.1 Algorithm for locally advanced colon cancer

Table 65.1 American Joint Committee Colon Cancer (AJCC) Definitions

Primary tumor (T)	
TX	Primary tumor cannot by assessed
T0	No evidence of primary tumor
Tis	Carcinoma in situ: intraepithelial or invasion of lamina propria
T1	Tumor invades submucosa
T2	Tumor invades muscularis propria
T3	Tumor invades through the muscularis propria into pericolorectal tissues
T4a	Tumor penetrates to the surface of the visceral peritoneum
T4b	Tumor directly invades or is adherent to other organs or structures
Regional lymph nodes (LN)	
NX	Regional LN cannot be assessed
N0	No regional LN metastasis
N1	Metastasis in 1–3 regional LN
N1a	Metastasis in one regional LN
N1b	Metastasis in 2–3 regional LN
N1c	Tumor deposits(s) in the subserosa, mesentery, or nonperitonealized pericolic or perirectal tissues without regional nodal metastasis
N2	Metastasis in 4 or more regional LN
N2a	Metastasis in 4–6 regional LN
N2b	Metastasis in 7 or more regional LN
Distant metastasis (M)	
M0	No distant metastasis
M1	Distant metastasis
M1a	Metastasis confine to one organ or site
M1b	Metastases in more than one organ/site or the peritoneum

Table 65.2 Anatomic Stage/Prognostic Groups

Stage	T	N	M
0	Tis	N0	M0
I	T1	N0	M0
	T2	N0	M0
IIA	T3	N0	M0
IIB	T4a	N0	M0
IIC	T4b	N0	M0
IIIA	T–T2	N1/N1c	M0
	T1	N2a	M0
IIIB	T3–T4a	N1/N1c	M0
	T2–T3	N2a	M0
	T1–T2	N2b	M0
IIIC	T4a	N2a	M0
	T3–T4a	N2b	M0
	T4b	N1-N2	M0
IVA	Any T	Any N	M1a
IVB	Any T	Any N	M1b

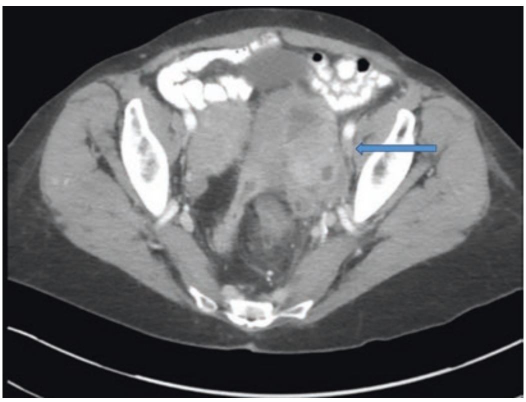

Fig. 65.2 Sigmoid cancer invading left adnexa

and occasionally and uniquely, symptoms related to the organ invaded. For example, feculent vaginal or urethral discharge implies a uterine, tubal, or bladder malignant fistula. Back pain may be present with invasion of the retroperitoneum or kidneys. Small bowel obstruction may signal invasion of loops of bowel. The majority of advanced colon cancers are unanticipated and revealed by imaging or at operation (Fig. 65.2).

D. Evaluation begins with preoperative imaging and endoscopy. No matter the presentation, evaluation of the colon with tissue diagnosis is paramount. For example, diagnoses such as lymphoma may present with retroperitoneal invasion and may warrant a different approach. Colonoscopy with biopsy is ideal and affords an opportunity to rule out additional treatable colonic pathology as well. In addition to, or in lieu of, endoscopic evaluation, barium or gastrograffin enema may be necessary to clear the colon proximal to a partially obstructing mass that is not accessible to a colonoscope. The use of barium should be done with caution particularly if there is suspicion of bladder, uterine or retroperitoneal invasion. Inspissated barium may form concretions or create a nidus of inflammation in these structures that heightens risks of infectious complications. Gastrograffin does not provide the same level of mucosal detail, but is able to rule out gross lesions and represents a good alternative. Computed tomography (CT) of the abdomen and pelvis with oral and intravenous contrast is imperative to rule out distant metastatic disease, better define the pathology, and provide a "road map" for operative intervention. Chest CT or plain radiograph and serum carcinoembryonic antigen (CEA) completes the typical preoperative staging.

E. Special considerations are made for preoperative knowledge of organ invasion. Preoperative cystoscopy may better define extent of bladder involvement and help premeditate the need for a more radical approach. Tumors that invade near the trigone, for example, may mandate radical cystectomy with urinary conduit creation as opposed to those tumors that invade the dome of the bladder which may be resected while conserving the remainder of the organ. Knowledge of this preoperatively is mandatory for operative planning, stoma marking, urinary stent placement and ensuring participation of specialty teams (urology). Similarly, knowledge of gynecologic involvement may necessitate additional specific testing such as transvaginal ultrasound or magnetic resonance imaging (MRI) to obtain a more specific delineation of involved structures and provide guidance for specialty surgeons' involvement

(GYN-Oncology). Another fairly commonly seen situation occurs when colon cancers at the hepatic flexure invade the duodenum. Preoperative endoscopic evaluation should be done as it provides crucial information regarding location of the invading neoplasm in relationship to the ampullary structures and informs decision-making.

F. The primary goal of surgical resection for locally advanced colon cancer involves resection of the colon with *en bloc* resection of the adjacent organ and adequate lymphadenectomy. An R0 resection has a significantly better prognosis than one with microscopic (R1) margins. As indicated, anticipation of the need for resection of adjacent organs may aid the ability to resect completely by ensuring adequate additional expertise availability. Reconstruction of the resected structures is a secondary, though crucial task.

G. Inability to resect may be encountered—particularly when the cancer invades retroperitoneal structures. Invasion of the major vessels—aorta, IVC, iliac vessels, and/or the presence of bulky periaortic adenopathy that precludes complete removal may limit R0 resection. Resection of the primary is shown to have value as a palliative maneuver to prevent obstruction or complications at the site of invasion such as urosepsis, chronic feculent vaginal discharge, uterine infection, or obstruction of the ampullary structures in the case of an invading hepatic flexure mass. Infectious complications may limit ability to deliver chemotherapy afterwards and alter the ability to treat effectively. Resecting the source of potential sepsis may allow more prolonged, sustainable chemotherapy delivery.

H. Right sided colon cancers may invade the right kidney, right ureter, duodenum, or fallopian tube/ovary. Figures 65.2 and 65.3. An appendiceal neoplasm in particular can demonstrate extension into gynecological structures or the sigmoid colon. *En bloc* resection of intraperitoneal structures, in general, is not as difficult as resection of those structures and organs in the retroperitoneum. The ability to mobilize and get margins on an intraperitoneal structure such as an ovary, uterus, or fallopian tube is quite straightforward whereas invasion into the ureters presents a distinctly difficult scenario. Ureteral invasion, because of the close margins involved and lack of lateral and retroperitoneal space, is a poor prognostic feature. Hydroureter on preoperative imaging connotes a grave scenario and distinctly poor outcome. It is more commonly seen in locally invasive rectal cancers but can be a problem in more proximal tumors as well. Mid and distal ureters should be resected *en bloc* with the tumor. A psoas hitch procedure or Boari flap may be used to reconstruct the urinary system in these cases. Mid or more proximal ureteral resections may be accompanied by either ureteroureterostomy or mobilization of the kidney and collecting system to facilitate a ureteroureteral anastomosis over a stent—although this has a higher rate of stricture, this can be useful in very proximal resections. Invasion of the upper ureter near the renal collecting system or invasion of the collecting system may require nephrectomy. Again, preoperative anticipation of this situation from imaging is helpful. Preoperative determination of con-

Fig. 65.3 Air in the uterus and vagina from invading sigmoid colon cancer

tralateral renal function may help make difficult decisions regarding kidney salvage or sacrifice easier intraoperatively. Duodenal invasion can be difficult to determine preoperatively. Superficial invasion is suspected when the colon cannot be mobilized off of the duodenum easily. It is often possible, because invasion occurs on the antimesenteric aspect of the duodenum, to resect the wall of the duodenum *en bloc* with the colon and then reconstruct the duodenum afterwards either with a TA stapler or with sutures. In rare cases of ampullary or pancreatic invasion, it may be necessary to perform a pancreaticoduodenectomy with intent to cure. Although this is a morbid and rare operation for this indication, the prognosis for a true T4b (with or without nodal involvement) colon cancer completely resected with negative margins is far better than that for a pancreatic primary lesion. Careful examination of the liver and intraperitoneal surfaces to rule out metastatic disease should be undertaken prior to embarking on this operation.

I. Left colon cancers and those of the transverse colon may invade stomach, left kidney, and spleen. These situations are fairly rare and again, can and should be anticipated with preoperative imaging. The stomach is particularly amenable to reconstruction and the spleen can be excised *en bloc* with the splenic flexure. The same considerations for the left kidney should be made as that previously mentioned for the right.

J. Sigmoid colon cancers with local invasion are the most common, both because it is the most frequent location for colon cancer and because the sigmoid colon is an intraperitoneal structure that may approximate several organs as well as small bowel. Gynecologic structures and urinary bladder are the most commonly affected, but appendix, cecum, and small bowel may be involved as well. The same principles of *en bloc* resection and reconstruction addressed with right sided and transverse tumors exist with sigmoid lesions and were mentioned previously.

K. Both T4a and T4b tumors are considered high risk for recurrent disease and confer a poorer prognosis than tumors that lack locally invasive features. T4b tumors are thought to be higher risk for both local and distant failure. Chemotherapy is suggested in about 20% of those patients who present with Stage II disease and T4 status is one of the features that most oncologists would agree deserves adjuvant chemotherapy and constitutes “high risk” for recurrence along with inadequately sampled lymph nodes, perforation at the tumor site, poor differentiation and lymphovascular invasion. It should be noted that there are no randomized trials directly comparing chemotherapy to no chemotherapy for high risk Stage II tumors including T4a and b tumors and there are no trials demonstrating benefit from chemo for those with high risk features. Also, no treatment comparison data exists between high and low risk Stage II patients either. However, the clinical rationale for chemotherapy in these patients is compelling enough to base the recommendation for chemotherapy on underpowered subset analyses of existing studies as well as extrapolated data from Stage III patients, and the knowledge that overall survival in this particular high risk cohort is significantly less than Stage III cancers. The use of infusional 5-fluorouracil (5-FU) with oxaliplatin is typically recommended in patients with no contraindications to these agents although the data comparing the use of 5-FU (plus levamisole) alone versus 5-FU with oxaliplatin is underpowered, and existing subset analysis shows no difference in overall survival between high risk and low risk Stage II patients. Those with locally invasive high risk features were not individually analyzed. Alternatively, capecitabine is an option in lieu of 5-FU. Those patients whose tumors are microsatellite unstable-high, may actually do worse than those who exhibit microsatellite stable tumors and in general, chemotherapy is not recommended for these Stage II patients.

L. The neoadjuvant use of chemotherapy and/or radiation for locally advanced colon cancers with a goal of reducing tumor volume and increasing resectability is not well studied for several reasons: pathologic staging of colon cancer has always been the basis of treatment; the presence of local tumor extension is often only appreciated intraoperatively, intra-abdominal radiation is associated with damage to adjacent structures that are difficult to protect and exquisitely radiosensitive such as small bowel, there is very little data to suggest that preoperative chemotherapy is beneficial, and there is real danger of over-treating a large percentage of patients based on clinical imaging who may do well with surgery alone. If imaging suggests the presence of a T4b lesion, the use of chemotherapy may be appropriate if resectability is in question and the patient is relatively asymptomatic. Lesions with retroperitoneal or solid organ involvement, may be candidates for a neoadjuvant approach, for example. Those with malignant fistulas into genitourinary structures are often thought to be at higher risk for sepsis while on chemotherapy. In general, these are best resected primarily if amenable, or diverted proximally if not. There are no randomized trials of pre-versus post-operative chemotherapy for any stage colon cancer.

M. The use of radiation for locally advanced colon cancers is controversial. In 2004, a randomized trial (Intergroup-0130) of radiation therapy in the adjuvant setting for high-risk colon cancers was published. It closed after accruing only 222 patients (700 goal) because of difficulty with enrollment. Because the data showed no improvement in overall or disease-free survival, and because there was significant toxicity, there has been very little enthusiasm for pursuing further studies of this treatment. Even so, there has been publication of both small single institution trials (1) and reviews of single institution experience that suggests that selected use of radiation, with chemotherapy for R1 or R2 resections may have some benefit. None of these studies is powered sufficiently to be conclusive, but they do show that subsets of T4b patients who are also node positive with R1 or R2 resection margins may have some benefit and enjoy better overall and disease-free survival. Outlining the resection bed with surgical clips intraoperatively can often help the radiation oncologist be more specific in targeting the residual or "at-risk" areas. The use of radiation is suggested on a case-by case basis and existing data suggests that radiation in patients with tumors that have a retroperitoneal location, margin positivity, and malignant regional lymphadenopathy may be beneficial.

Conclusion

Locally advanced colon cancers are not common—particularly those with invasion into adjacent structures (T4b), and they represent unique challenges. The use of good quality CT scanning for preoperative staging helps to anticipate local invasion. Use of additional testing like cystoscopy and small bowel follow through can help to specifically pinpoint extent of involvement and help direct a multidisciplinary approach, if necessary. The goal of surgery is *en bloc* resection with negative or R0 margins. While this may be easier when intraperitoneal structures are involved such as fallopian tubes, ovaries, uterus and loops of small bowel, it may be a far greater challenge to achieve clear margins on cancers invading the retroperitoneum and involving structures such as ureters. Chemotherapy for high risk Stage II lesions is strongly encouraged based on extrapolated evidence from Stage III data and recognizing that data for Stage II cancers is limited. T4a and b cancers are considered high risk features whose presence confers a worse overall survival rate than patients with Stage III disease. Radiation is probably best reserved for those patients with bulky retroperitoneal tumors resected en bloc with threatened margins. Marking the bed of these tumors with radiopaque clips aids post-operative radiation targeting. T4 lesions with R1 or R2 features and LN positivity are probably the best candidates for post-operative radiation treatment.

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Recurrent Colon Cancer

66

David Liska and Luca Stocchi

Refer to Algorithm in Fig. 66.1

A. The majority of patients initially diagnosed with colon cancer have localized disease amenable to curative resection. However, despite curative intent surgery and modern adjuvant chemotherapy, disease recurrence remains a major concern after resection. The incidence of overall recurrence after curative surgery depends on disease stage and ranges from less than 10% for stage I disease to approximately 40% for stage III disease. Recurrences most commonly present with distant metastases in the liver or lung. Locoregional recurrence (LR) is relatively rare and ranges from 3 to 12% in different series, with advanced tumor stage, and locally infiltrating disease with adjacent organ invasion or perforation, being the strongest predictors for recurrence. LR presents without synchronous distant metastases in 50–80% of cases. The majority of recurrences (~80%) occur within the first 3 years after surgery while conversely less than 2% occur after 5 years.

B. The ideal goal of colon cancer surveillance is the ability to detect recurrences early enough to allow salvage surgery. Several randomized trials have demonstrated that more intense surveillance regimens are associated with an increase in the number of patients who can be treated with curative intent, although this remains somewhat controversial. The optimal frequency and specific surveillance tests to be used are still a matter of debate. The American Society of Colon and Rectal Surgeons (ASCRS) practice guidelines for surveillance of patients with stage II or III colon cancer recommend regularly scheduled office visits and CEA testing every 3 to 6 months for the first 2 years, and then twice a year for a total of 5 years, and annual cross sectional chest and abdominopelvic imaging for 5 years. Colonoscopy is recommended at 1 year after surgery with subsequent examinations every 3–5 years depending on findings during the initial colonoscopy.

C. When the diagnosis of recurrent colon cancer is entertained due to new symptoms, rising CEA level, or imaging abnormalities, it is imperative to perform an evaluation that will allow for definitive confirmation of recurrence and a complete assessment of both local and distant disease. All patients should have cross sectional imaging of the chest,

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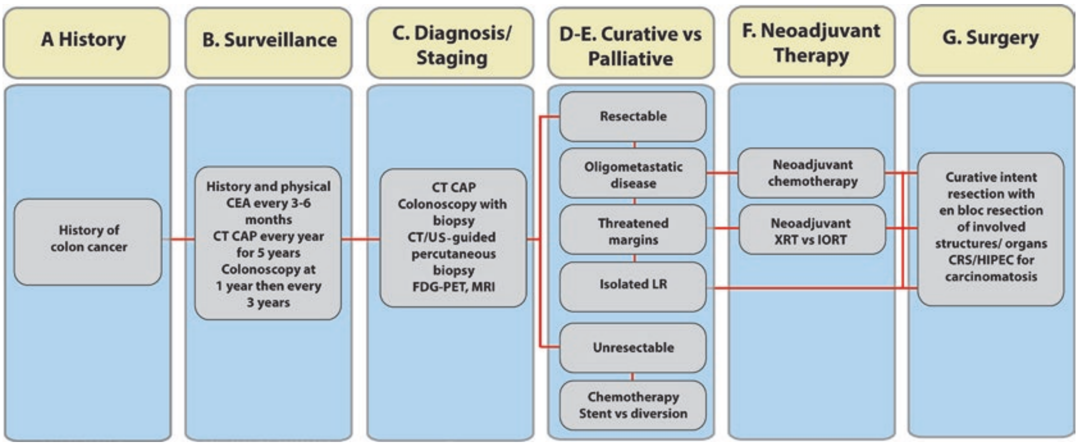

Fig. 66.1 Algorithm for Recurrent Colon Cancer. *LR* local recurrence, *XRT* radiation therapy, *IORT* introperative radiation therapy, *CRS* cytoreductive surgery, *HIPEC* heated intra-peritoneal chemotherapy

abdomen, and pelvis to allow for the detection of any distant metastases. While a full colonoscopy is essential to assess the prior anastomosis for recurrence and the residual colon for any metachronous lesions, the majority of recurrences are extraluminal and are therefore not amenable to endoscopic biopsy. CT or ultrasound-guided biopsies should be performed to confirm the diagnosis. In cases not amenable to percutaneous biopsy PET scans are now routinely used to assist in establishing the diagnosis of recurrent disease (Fig. 66.2). When clinical suspicion (due to new symptoms and/or CEA elevation) is confirmed by cross sectional and functional imaging, the absence of a tissue diagnosis should not preclude treatment. When there is a concern for local invasion of adjacent organs, bone, nerves, or blood vessels, contrast enhanced MRI should be employed to assess for tumor resectability and operative planning.

D. Once the diagnosis of recurrent colon cancer has been established, the most important question to answer is if salvage surgery with curative intent is ultimately possible. This assessment depends on the local and distant extent of disease and the overall medical condition of the patient. Review of the patient's medical and treatment history, imaging, and pathology specimens in the setting of a multidisciplinary disease management team (*i.e.*, tumor board) is essential when considering all possible treatment options. Widespread metastatic disease, extensive invasion into large vessels or nerves, or major comorbid conditions are factors that preclude curative intent surgery. In these cases the focus should shift to control of disease progression with chemotherapy and palliation of symptoms.

E. Patients with a colonic obstruction—in the setting of recurrent disease that is not amenable to curative resection—present a significant challenge in selecting the optimal treatment modality. The possible treatments include a palliative resection with or without restoration of intestinal continuity, fecal diversion with a diverting ostomy, intestinal by-pass, or endoscopic deployment of a self-expandable metal stent (SEMS). Especially in patients with distal obstructions, SEMS can be an attractive option for palliative treatment due to the minimal invasiveness of the procedure. In experienced hands, SEMS can be deployed with very high technical and clinical success rates, resulting in rapid resolution of the obstruction with short hospital stay and minimal recovery. However, stents are associated with a risk of perforation, migration, and re-obstruction, often necessitating subsequent procedures or surgeries. Surgical treatment with resection or fecal diversion provides more durable palliation at the cost of increased peri-operative morbidity, length of hospital stay, and need

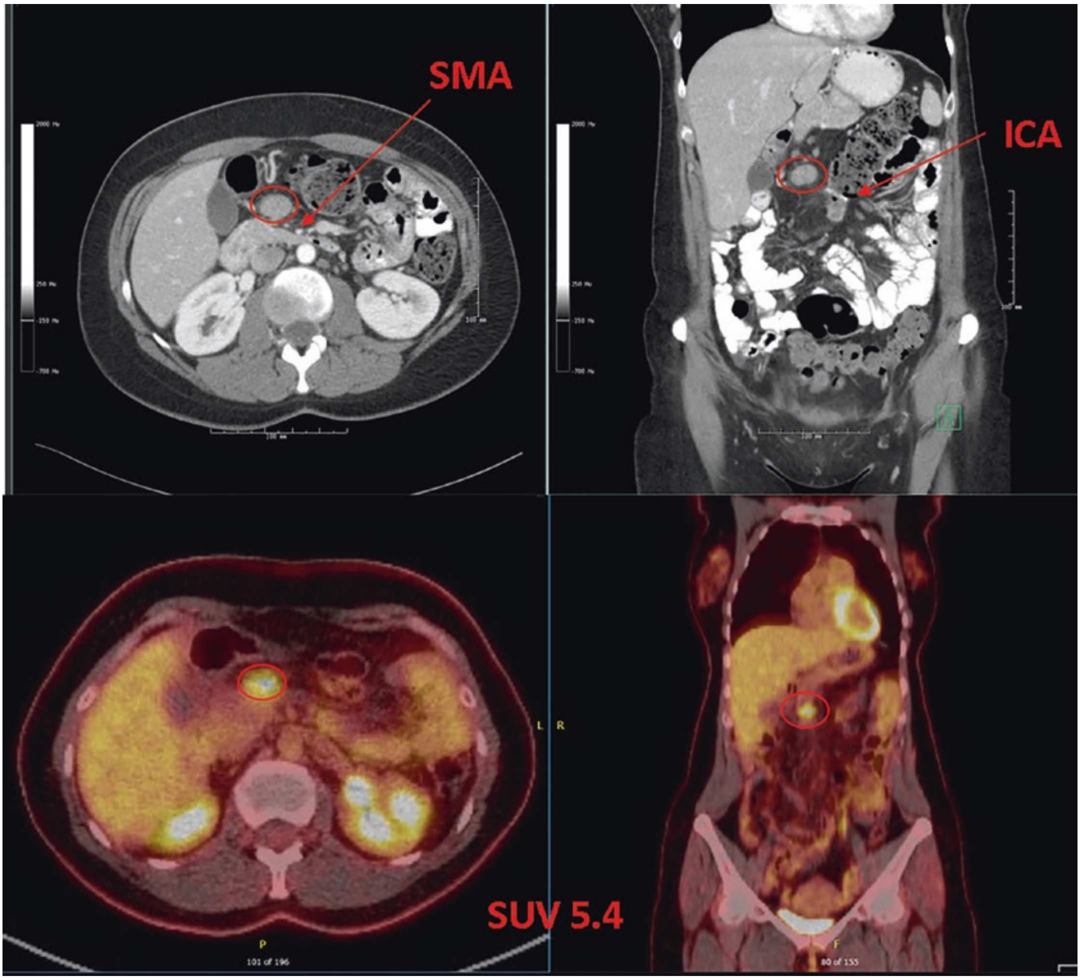

Fig. 66.2 Imaging one year following right hemicolectomy for hepatic flexure adenocarcinoma: CT with contrast and subsequent PET/CT demonstrating FDG avid lymph node recurrence adjacent to the superior mesenteric artery (SMA) and ileocolic anastomosis (ICA)

for an ostomy. Palliative treatment decisions need to be individualized, and should be based on available resources, estimated patient life-expectancy, and quality of life considerations.

F. Medically fit patients with resectable disease are candidates for treatment with curative intent. The decision to proceed with immediate surgery versus preoperative chemotherapy or radiotherapy needs to be individualized based on the location of the local recurrence, presence of metastases, and previous treatment regimens. Preoperative chemotherapy should be strongly considered for patients with LR in the setting of oligometastases to the lung or liver. Advantages of preoperative administration of chemotherapy include the ability to eradicate micrometastatic disease, to reduce the size of gross disease requiring resection, and to assess for chemotherapeutic sensitivity to help guide future treatment decisions. Potential disadvantages of preoperative chemotherapy include toxicities that may increase the risk of perioperative morbidity, and the possibility of tumor progression while awaiting surgery. In general, though, patients with significant metastatic disease progression while on preoperative chemotherapy are unlikely to benefit from radical surgery and can thereby be selected

for palliative treatments prior to embarking on morbid, unhelpful surgical procedures. Recurrent locoregional disease with threatened resection margins warrants consideration for preoperative chemotherapy to reduce the risk of subsequent local recurrence. The use of combined radiotherapy to maximize local control is more controversial. In cases where preoperative external beam radiotherapy (EBRT) would entail toxicity to dose-sensitive viscera, or in cases of previous irradiation, intraoperative radiotherapy (IORT) can be used to allow precise delivery of a single large fraction of radiation to high risk target areas while shielding radiosensitive viscera. While there is evidence supporting the role of IORT in recurrent rectal cancer, this approach has been less frequently described in the management of colon cancer.

G. Multiple studies have confirmed that outcomes following salvage surgery for locally recurrent colon cancer are strongly associated with completeness of resection. It is therefore imperative to plan for radical surgery with *en bloc* resection of any involved adjacent structures to obtain microscopically negative margins (R0). Patients with LR can frequently present with associated physiologic deficits such as malnutrition, anemia, and immunosuppression from cytotoxic medications. Appropriate preoperative planning should, whenever possible, include addressing these deficits with enteral (or if needed parenteral) nutritional supplementation, iron or blood supplementation, and a sufficient break from chemotherapy to allow for blood count normalization. While some selected patients can be treated with a laparoscopic approach, the majority of patients will require open surgery with a midline incision to allow for optimal assessment of disease extent and oncologic resections. Surgical oncologic principles need to be followed, including minimal handling of the tumor, wound protection, high ligation of lymphovascular pedicles, and *en bloc* resection of involved adjacent structures. The liver and peritoneum should be carefully inspected for any evidence of metastatic disease. When in doubt, intraoperative ultrasound and frozen sections should be obtained. Liberal use of ureteral stents can aid in the identification of the ureters, especially for tumors involving the retroperitoneum. Anastomotic recurrences will require resection of the anastomosis and supplying mesentery. Given the history of previous resections in these patients it is important to carefully assess the blood supply to the remaining colon. In patients at increased risk for anastomotic leaks, judicious use of diverting stomas can minimize the risk of abdomino-pelvic infections that could prevent the timely completion of postoperative chemotherapy. It has been shown that as long as an R0 complete resection is achieved, neither the extent of surgery nor the performance of multivisceral resections are predictors of poor outcomes. It is therefore recommended to resect adherent structures or organs and avoid attempts at dissection to prevent potential tumor spillage and recurrence. Resections may encompass adjacent solid organs such as pancreas, spleen, liver, urological, or gynecological structures, other segments of bowel, or the abdominal wall. Oligometastatic synchronous liver disease can either be addressed concomitantly or in a staged fashion. For primary colon cancer presenting with synchronous resectable liver metastases there are studies supporting either approach. There are limited data in the recurrent colon cancer setting, however we usually recommend a staged approach for liver disease requiring hemihepatectomies or extended resections.

H. There are few small series specifically describing the outcomes of patients undergoing surgery for locally recurrent colon cancer (Table 66.1). For patients undergoing successful resections with microscopically negative margins, 5-year disease-specific survival ranges between 25 and 46%. Conversely, patients with residual macroscopic tumor have dismal outcomes, confirming that in patients with LR unsuitable for complete resection, surgery should only be performed for the palliation of symptoms. Other factors

Table 66.1 Outcomes following curative intent surgery for locoregionally recurrent colon cancer

Study	n	Distant metastases (%)	Resection R0/R1/R2 (%)	Median F/U (months)	5-year survival (%)	5-year survival R0/R1/R2
Taylor 2002	71	Excluded	52/26/22	70.5	24.7[a]	37.4/25.1/0[a]
Bowne 2005	100	26	56/11/19	27	35[b]	57/0/0[b]
Akiyoshi 2011	45	31	89/11/–	51	46[b]	51/0/–[b]
Harji 2013	42	43	18/21/3	NS	40[a]	29/26/16[c]

NS not specified
R0 microscopically negative margins, R1 microscopically positive margins, R2 macroscopic tumor remaining
[a]Overall survival
[b]Disease-specific survival
[c]Median survival in months

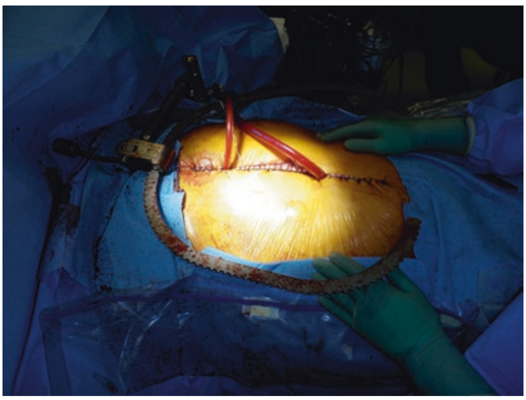

Fig. 66.3 Heated intraperitoneal chemotherapy (HIPEC)

found to be associated with poor outcomes include: more than one site of LR or distant metastases, recurrence in the mesentery/nodal basin or peritoneum, high pathological grade, and large tumor size.

I. Special consideration needs to be given to patients presenting with LR in the setting of peritoneal carcinomatosis (PC). Approximately 20–50% of patients with recurrence will present with peritoneal disease. PC from colon cancer has traditionally been viewed as a contraindication to surgery. Even with the most aggressive systemic chemotherapy these patients have only a 15–24 month median survival. Cytoreductive surgery (CRS) and heated intraperitoneal chemotherapy (HIPEC) (Fig. 66.3) have been used for the treatment of other peritoneal malignancies with promising results. More recently these techniques have also been used in the management of PC of colorectal origin. CRS, as described by Sugarbaker, refers to the surgical excision of all visible intraperitoneal tumor deposits by peritoneal stripping and visceral resections when required. The CC (completeness of cytoreduction) score is used to assess the amount of disease remaining after CRS. It ranges from 0 to 3, with CC = 0 indicating that no macroscopic disease remains. Following CRS, a heated chemotherapeutic agent (usually mitomycin-C or oxaliplatin) is intraoperatively administered to the peritoneal cavity. Multiple recent studies have now demonstrated that CRS and HIPEC can be performed safely with low mortality and acceptable morbidity resulting in 5-year survival ranging from 26 to 43%. Despite significant variability among studies in the absence of standardized techniques, there is also evidence supporting CRS and HIPEC as a valid treatment for selected, medically fit patients with peritoneal carcinomatosis in the setting of recurrent colon cancer. There is emerging evidence showing that similar outcomes can be obtained even in some patients with PC and synchronous liver metastases.

J. It is currently unclear if patients rendered disease-free with R0 resections benefit from adjuvant chemotherapy. While guidelines from the National Comprehensive Cancer Network (NCCN) recommend six months of adjuvant chemotherapy after resection of colorectal cancer liver metastases, they do not specifically address the usefulness of chemotherapy after resection of a local recurrence.

The decision must be individualized and is based, in part, on whether any chemotherapy to address LR (particularly an oxaliplatin-containing regimen) was previously administered. Select patients with close resection margins who have not received preoperative EBRT or IORT may benefit from postoperative EBRT. Marking the area of concern with radiopaque clips at the time of surgery can help target the appropriate radiation field.

K. In summary, locoregional recurrence in colon cancer is relatively rare but when present is associated with poor outcomes. Close surveillance of patients at high risk for recurrence can help detect LR when still curable. Surgical treatment is the only chance for long-term survival but is technically challenging due to local extent of the disease. Appropriate surgical planning and anticipating the need for an extended resection with *en bloc* removal of involved adjacent structures or organs, is critical for achieving microscopically negative margins and optimal outcomes. Resectable distant oligometastatic disease is not a contraindication to surgery with curative intent. Well selected patients with peritoneal carcinomatosis can benefit from cytoreductive surgery and HIPEC. A multidisciplinary evaluation is needed to determine an individualized approach in terms of preoperative, surgical, and adjuvant management.

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Appendiceal Neoplasms

67

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Refer to Algorithm in Fig. 67.1

A. Many tumors of the appendix present acutely, often initially mistaken for acute appendicitis and are only found intra-operatively or following pathology examination. Others present as asymptomatic incidental lesions during a work-up for other symptoms (*i.e.*, CT scan) and allow the opportunity for a more definitive evaluation. Appendiceal tumors can be divided into epithelial (*i.e.*, adenoma, adenocarcinoma), non-epithelial (*e.g.*, carcinoid), and mixed lesions. Other rare lesions include sarcomas, lymphomas, and mixed lesions such as goblet cell carcinoids.

B. Appendiceal neoplasms are rare, with a reported incidence of 1.2 cases per 100,000 people per year in the United States. In general, the history and physical examination are non-specific. Patients are often over 50 years of age, with a mean age of 62–65 years, and there is a slight male predominance. In many cases, patients are asymptomatic, especially in early stage disease. Those patients with symptoms may present with right lower quadrant abdominal pain (mimicking appendicitis), which is classically from obstruction of the lumen by the tumor. As disease progresses, mucin throughout the abdomen (*i.e.*, pseudomyxoma peritonei) may lead to abdominal distension, obstructive symptoms and even a mass. Unfortunately this indicates advanced disease.

C. Radiological evaluation is one of the most important aspects for evaluation. Plain radiographs may be indicated in those patients with a concern for obstruction or perforation, although non-specific. Cross-sectional imaging with CT is useful both in the initial evaluation as well as for surveillance. CT will help in the staging of mucinous adenocarcinoma to evaluate for lymph node and distant metastases. CT will also help with calculation of the peritoneal cancer index (PCI) (Fig. 67.2). Abdominal MRI has been incorporated in several surveillance strategies to follow solid and mucinous peritoneal disease. Both allow for evaluation of the appendix as well as the entire abdomen (Table 67.1). Fluoroscopic studies such as small bowel follow-through and gastrografin enema are seldom indicated as primary studies. PET scans may be helpful for solid tumors to detect recurrence but typically are unreliable for small lesions <1 cm and not helpful for detecting pseudomyxoma peritonei. Somatostatin receptor scan may be used in those patients with carcinoid tumors >1 cm to help detect distant disease.

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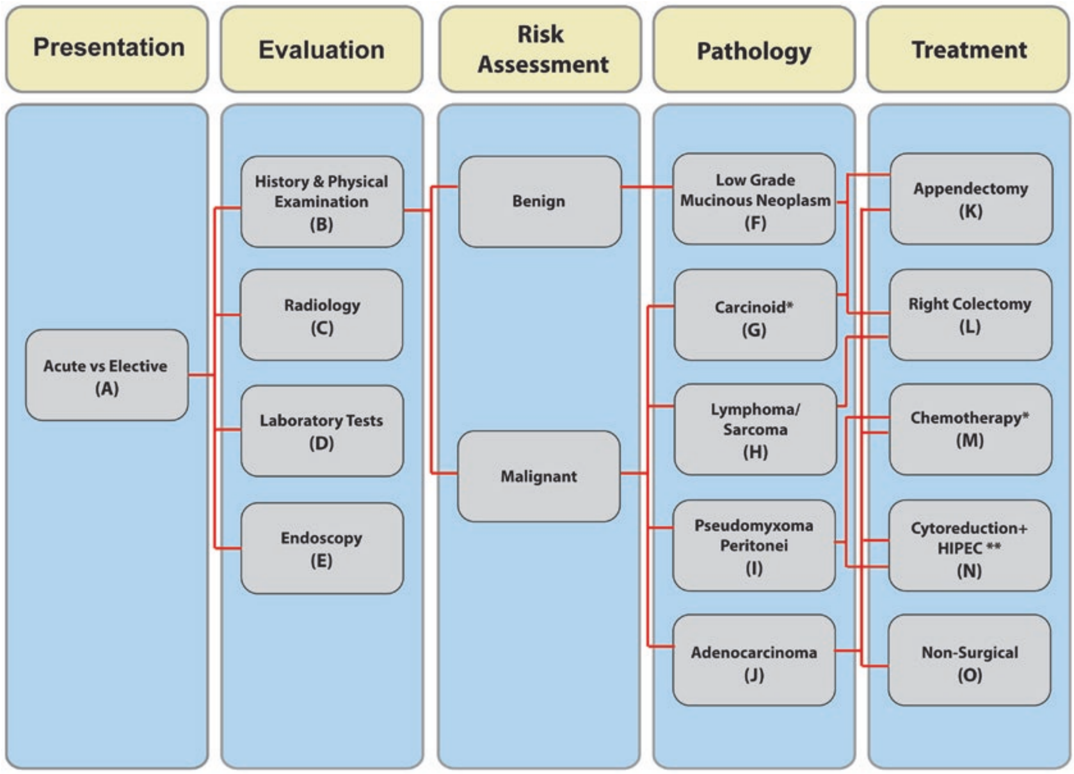


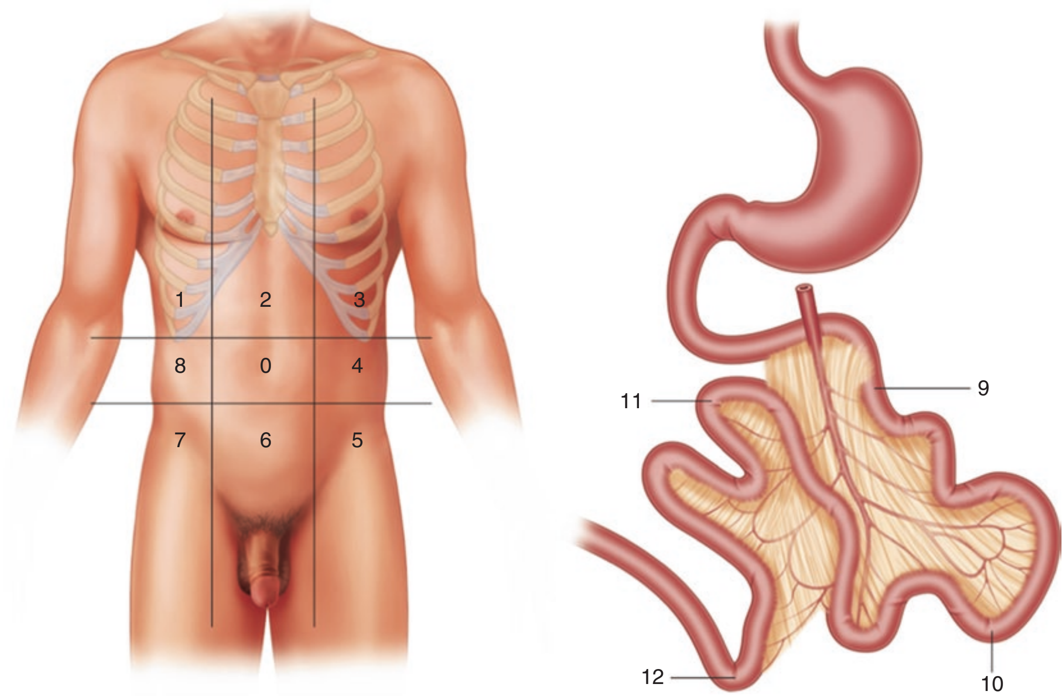
Fig. 67.1 Algorithm for appendiceal neoplasms. ∗Appendectomy for <1 cm lesions and negative margins; Right colectomy for >2 cm lesions, positive (or questionable) margins, nodal involvement, invasion of mesoappendix >3 mm, or metastases to the liver only; Chemotherapy for diffuse metastases >1 site; $ May require HIPEC and cytoreduction in the setting of diffuse mucinosis; ∗∗ Diffuse mucinosis with PCI <16–20, or perforated primary without pseudomyxoma peritonei; # Diffuse mucin or carcinomatosis with PCI >16–20, diffuse systemic metastases, or carcinomatosis with concomitant metastases

D. There is no diagnostic laboratory test for the majority of the appendiceal tumors. Laboratory testing may include baseline CBC, chemistry and coagulation panels as indicated by appropriate risk stratification. For patients with suspected epithelial lesions, the tumor marker carcinoembryonic antigen (CEA) should be evaluated. Carcinoid lesions may be evaluated with urinary 5-HIAA metabolites and serum chromogranin A.

E. Endoscopy is not classically useful to detect the primary lesion. In some cases, mucin may be visualized extruding from the appendiceal orifice that may suggest the presence of a mucinous neoplasm. More importantly, those patients with an appendiceal neoplasms including carcinomas, carcinoid and neuroendocrine tumors have an ~10–20% risk of concomitant lesions elsewhere in the colon. Prior to any surgical intervention, endoscopic clearance of the colon should be performed.

F. Nomenclature for mucinous neoplasms of the appendix is evolving and contributes somewhat to the confusion regarding the optimal treatment. In general, low-grade mucinous neoplasms encompass serrated or villous adenomas, cystadenoma, or mucinous neoplasms of uncertain behavior. Of note, mucocele is a morphologic term to describe a dilated fluid filled appendix, and does not relate to the biological aggressiveness. They are slow-growing and typically indolent. They may rupture (or iatrogenically ruptured during surgery), leading to mucin throughout the abdomen. Localized tumors may typically be treated with appendectomy

Peritoneal Cancer Index



Regions	Lesion size	Lesion size score
0. Central	——	LS 0 No tumor seen
1. Right upper	——	LS 1 Tumor up to 0.5 cm
2. Epigastrium	——	LS 2 Tumor up to 5.0 cm
3. Left upper	——	LS 3 Tumor > 5.0 cm or confluence
4. Left flank	——	
5. Left lower	——	
6. Pelvis	——	
7. Right lower	——	
8. Right flank	——	
9. Upper jejunum	——	
10. Lower jejunum	——	
11. Upper ileum	——	
12. Lower ileum	——	
PCI	$\boxed{}$	

Fig. 67.2 Peritoneal Cancer Index (PCI). This is a collective score with a maximum of 39 points from nine abdominal squares and 4 small bowel segments. Each area is scored between 0 (no disease) to 3 (deposits are >5 cm)

and have good long-term prognosis. If epithelial cells are present outside the appendix in the peritoneum, this may lead to more aggressive behavior and result in pseudomyxoma peritonei **(refer to section I in algorithm in** Fig. 67.1).

G. Carcinoid (Neuroendocrine) tumors of the appendix are derived from hormone-active neuroendocrine cells. While various hormones (growth hormone, calcitonin) may be produced, most commonly they secrete serotonin, which is subsequently metabolized to 5-hydroxyindoleacetic acid (5-HIAA). This metabolite is excreted in the urine and classically used to monitor disease. The majority are located at the tip of the appendix, are less than 1 cm, and when large can be associated with a desmoplastic inflammatory response

Table 67.1 Characteristics of Appendiceal Neoplasms on Cross-Sectional Imaging

Lesion	Appearance
Mucocele	Encapsulated dilated appendix filled with intraluminal mucin ± calcifications
Adenocarcinoma	Mucinous: Soft tissue mass-like lesion with cystic dilation and possible invasion through the wall ± disseminated mucin throughout the abdomen; Non-mucinous: Soft tissue mass-like lesion with cystic dilation with possible invasion through the well± lymphadenopathy ± liver metastases
Carcinomatosis	Mucin or clusters of tumor throughout the peritoneum with involvement of peritoneal surface, parenchyma and/or omentum
Carcinoid	Most commonly normal or with localized inflammation;[a] Occasionally with soft-tissue mass within the appendix or diffused mural thickening
Pseudomyxoma Peritonei	Intra-peritoneal low attenuation mucin (ascites) ± serosal implants

[a]Many lesions may present with localized appendiceal inflammation consistent with acute appendicitis or may be not visualized on cross-sectional imaging

Table 67.2 AJCC (seventh Edition) Staging Systems for Primary Appendiceal Neuroendocrine Carcinoma

AJCC	
Tumor	
T1a	≤1 cm greatest diameter
T1b	1–2 cm greatest diameter
T2	>2 cm but ≤4 cm or invasion of cecum
T3	>4 cm or extension to ileum
T4	Perforates peritoneum or invades other organs
Nodes	
N0	No regional lymph node involvement
N1	Metastasis to regional nodes
Metastasis	
–	–
M0	No distant metastasis
M1	Distant metastasis
Stage	
–	–
I	T1, N0, M0
II	T2/3, N0, M0
III	T4, N0, M0
	Any T, N1, M0
IV	Any T, any N, M1
I	T1, N0, M0

AJCC American Joint Committee on Cancer

in the mesentery. Outcomes correlate with stage, of which size is the primary factor (Table 67.2). While lymph node involvement is rare in lesions <1 cm, up to 30% of carcinoids over 2 cm will have nodal metastases. In general, outcomes are good, with 5-year survival for tumors limited to local and regional disease >80%; though 25–30% for stage IV disease. Goblet cell carcinoid represents a mixed epithelial and neuroendocrine tumor variant that presents with a wide spectrum of biological aggressiveness. Whereas the majority are incidental findings on appendectomy, ~10–15% will present with metastatic disease. Outcomes are typically worse than routine carcinoids with 5-year survival for patients with local/regional disease 45–82%, and those with stage IV disease <20%.

H. Lymphoma and sarcoma represent less common tumors than may be found in the appendix. Lymphoma is more common among these more rare conditions, yet the appendix may be the primary disease site. Patients are commonly 30–40 years old, and commonly present in with symptoms of appendicitis or obstructive symptoms from intussusception or local inflammation. Sarcomas are much rarer, with Kaposi's sarcoma and leiomyosarcoma among the subtypes.

I. Pseudomyxoma peritonei may occur in the setting of appendiceal tumors or those from peritoneal or ovarian sources. This process is describes mucin to varying degrees in the peritoneum as well as strong and mucinous epithelial cells. In the setting of appendiceal neoplasms, it results from a rupture of low-grade mucinous neoplasms. The outcome is directly proportional to the amount of mucin, which is a result of the degree of epithelial cell presence or absence in the mucin. Often this will be confined to the right lower quadrant, but may also present as disseminated peritoneal adenomucinosis or peritoneal carcinomatosis. The former may spread throughout the abdominal cavity, whereas the latter may also infiltrate the abdominal organs.

J. Adenocarcinoma of the appendix may include mucinous and non-mucinous subtypes. These tumors may rupture and lead to seeding of the peritoneal cavity and pseudomyxoma peritonei. These tumors invade the appendiceal wall and may spread by both nodal (less commonly) and peritoneal surfaces. Non-mucinous adenocarcinoma of the appendix closely resemble colonic adenocarcinoma with metastases more commonly to the lymph nodes and hematogenously to the liver. Outcomes correlate to colon cancer and are determined by the stage (Table 67.3). Mucinous subtypes have a comparatively worse prognosis than non-mucinous lesions. A variant of mucinous adenocarcinoma is the signet ring cell subtype that is much more aggressive and tends to lead to diffuse metastases throughout the peritoneal cavity. It characteristically has a very poor prognosis.

K. As many lesions are incidental findings or originally felt to represent appendicitis, appendectomy is one of the more common "diagnostic" modalities for appendiceal neoplasms. However, appendectomy en bloc with resection of the mucinous lesion may also be curative for localized, non-ruptured benign lesions, carcinoids <1 cm with negative margins, and benign mucoceles. When dealing with the latter, it is important to avoid perforation and spillage to minimize the changes of peritoneal mucinosis. Carcinoids 1–2 cm with otherwise negative features and clear margins may be candidates for therapy with an appendectomy;

Table 67.3 ACJJ staging (8th edition) of mucinous adenocarcinoma of the appendix

Primary tumor (pT)
T stage
• **TX**: primary tumor cannot be assessed
• **T0**: no evidence of primary tumor
• **Tis**: carcinoma in situ, intramucosal carcinoma (involvement of lamina propria with no extension through muscularis mucosae)
• **T1**: tumor invades submucosa (through the muscularis mucosa but not into the muscularis propria)
• **T2**: tumor invades muscularis propria
• **T3**: tumor invades through the muscularis propria into the pericolorectal tissues
• **T4**
– **T4a**: tumor invades through the visceral peritoneum (including gross perforation of the bowel through tumor and continuous invasion of tumor through areas of inflammation to the surface of the visceral peritoneum)
– **T4b**: tumor directly invades or adheres to other adjacent organs or structures
Notes
• Tis and T1
– Tis in the AJCC 8th edition refers only to intramucosal carcinoma, a lesion with invasion into the lamina propria that does not penetrate the muscularis mucosa
– Unlike in the 7th edition, lesions with high grade dysplasia without invasion into the lamina propria are not considered Tis and these lesions have no potential to spread
– Term intraepithelial carcinoma is synonymous to Tis but is rarely used (and may be misleading)
– True intramucosal carcinoma also lacks the potential for metastasis; however, because of the potential for missing invasion beyond the muscularis mucosa due to incomplete sampling, designating these lesions Tis is appropriate
– T1 lesions have invasion into the submucosa
• Carcinoma in a polyp
– Classified according to pT definitions used for colorectal carcinomas; i.e. invasive carcinoma in the muscularis mucosae or lamina propria is pTis and tumor that has entered the submucosa of the polyp's head or stalk is pT1
– If a resected polyp has a clear margin during endoscopic resection, it is a pTis lesion and the nodal and metastatic status is unknown; however, the risk of metastatic disease is very low and lymph node dissection is not indicated
– Several professional societies recommend resection if there is a high grade invasive tumor, the invasive tumor is 1 mm or less from the resection margin or lymphovascular space invasion is present

(continued)

Table 67.3 (continued)

• T4
– Separation of T4 into two categories (T4a and T4b) is based on different outcomes in expanded datasets
– T4a tumors directly invade the serosal surface (visceral peritoneum)
This includes tumors with perforation where the tumor cells are continuous with the serosal surface through inflammation
Some but not all studies indicate that tumors that are under 1 mm from the serosal surface show a higher risk for peritoneal relapse; if so, multiple levels and additional sampling should be performed and if serosal surface involvement is not found, the tumor should be considered pT3
pT4a should not be used in nonperitonealized portions of the colorectum (posterior aspects of ascending and descending colon, lower rectum)
Regional lymph nodes (pN)
• **NX**: regional lymph nodes cannot be assessed
• **N0**: no regional lymph node metastasis
• **N1**: metastasis in 1–3 regional lymph nodes
– **N1a**: metastasis in 1 regional lymph node
– **N1b**: metastasis in 2–3 regional lymph nodes
– **N1c**: no regional lymph nodes are positive but there are tumor deposits in the subserosa, mesentery or nonperitonealized pericolic or perirectal / mesorectal tissues
• **N2**: metastasis in 4 or more regional lymph nodes
– **N2a**: metastasis in 4 - 6 regional lymph nodes
– **N2b**: metastasis in 7 or more regional lymph nodes
Notes
• Minimum of 12 lymph nodes must be recovered for lymph node staging to be considered accurate in curative resections
• Number of recovered nodes has been reported to correlate with better prognosis, likely due to more accurate staging
• Metastasis to nonregional lymph nodes outside of the drainage area of the tumor, i.e. those not found along vascular arcades of the marginal artery or pericolonic, perirectal or mesorectal nodes should be considered distant metastasis (M1a)
• A lymph node metastasis that in other sites would be considered a micrometastasis is recorded as a “typical” metastasis
– Research is ongoing as to the possible significance of micrometastasis or metastasis only found with keratin staining
• N1c tumor deposits are discrete tumor nodules of any shape, contour or size that lack associated lymph node tissue, vascular structures or neural structures found within the lymph drainage area of the primary carcinoma
– These deposits are associated with poor overall survival
– In cases with lymph node metastasis, the number of tumor deposits is NOT added to the number of positive lymph nodes
Distant metastasis (pM)
• **M0**: no distant metastasis by imaging; no evidence of tumor in other sites or organs (this category is NOT assigned by pathologists)
• **M1**: distant metastasis
– **M1a**: metastasis confined to 1 organ or site without peritoneal metastasis
– **M1b**: metastasis to 2 or more sites or organs is identified without peritoneal metastasis
– **M1c**: metastasis to the peritoneal surface is identified alone or with other site or organ metastases
Notes
• Metastasis to nonregional lymph nodes outside of the drainage area of the tumor, i.e. those not found along vascular arcades of the marginal artery or pericolonic, perirectal or mesorectal nodes should be considered distant metastasis (M1a)
• Multiple metastases in an organ, even paired organs (ovaries, lungs), are still M1a disease
• Pathologist should not assign the global designation pM0, as metastasis unknown to the pathologist may be present

Table 67.3 (continued)

Prefixes			
• **y**: preoperative radiotherapy or chemotherapy			
• **r**: recurrent tumor stage			
• **a**: cancer discovered incidentally during autopsy			
Grading of quality and completeness of the mesorectum in a total mesorectal excision			
• **Complete**: intact and smooth mesorectum, defects if present are no deeper than 5 mm, there is no coning and the circumferential resection margin is smooth and regular			
• **Nearly complete**: mesorectum is moderately bulky and irregular, defects on muscularis propria are visible, there is moderate coning and an irregular circumferential resection margin			
• **Incomplete**: mesorectum has little bulk, the muscularis propria is visible through defects, there is moderate to marked coning and an irregular circumferential resection margin			
• See **J Clin Pathol 2007;60:849**			
Tumor regression after neoadjuvant therapy			
Modified Ryan scheme for tumor regression score (only performed on primary tumor)			
• **0 (complete response)**: no viable cancer cells			
• **1 (near complete response)**: single cells or rare small groups of cancer cells			
• **2 (partial response)**: residual cancer with evident tumor regression but more than single cells or rare small groups of cancer cells			
• **3 (poor or no response)**: extensive residual cancer with no evident tumor regression			
• See **CAP: Cancer Protocol Templates [Accessed 29 November 2017]**			
Notes			
• In rectal cancer, the pathologic response to preoperative radiotherapy, chemoradiation or chemotherapy in colon or rectal cancer is important prognostically			
• Acellular mucin is considered to represent completely eradicated tumor and should not be used to assign pT category or be considered positive lymph nodes			
T stage			
Stage 0	Tis	N0	M0
Stage I	T1–T2	N0	M0
Stage IIA	T3	N0	M0
Stage IIB	T4a	N0	M0
Stage IIC	T4b	N0	M0
Stage IIIA	T1–T2	N1/N1c	M0
	T1	N2a	M0
Stage IIIB	T3–T4a	N1/N1c	M0
	T2–T3	N2a	M0
	T1–T2	N2b	M0
Stage IIIC	T4a	N2a	M0
	T3–T4a	N2b	M0
	T4b	N1–N2	M0
Stage IVA	Any T	Any N	M1a
Stage IVB	Any T	Any N	M1b
Stage IVC	Any T	Any N	M1c

however, this is controversial due to the risk of lymph node metastases.

L. Right colectomy is reserved for patients with adenocarcinoma of the appendix and larger carcinoids (>2 cm; >1 cm with high-risk features; positive margins). Goblet cell appendiceal carcinoids have a 20–40% risk of lymph node metastases therefore a right hemicolectomy is recommended regardless of primary tumor size. For patients with low-grade mucinous neoplasms of the appendix in the setting of pseudomyxoma peritonei, there remains controversy. Whereas the traditional teaching has been right colectomy, more recently the shift has been towards appendectomy only and cytoreductive surgery ± HIPEC (see below). This is due, in part, to the fact that lymph node disease is a rare

entity and the peritoneal disease is the primary driver of patient outcomes.

M. Chemotherapy alone is typically for patients with metastatic disease who cannot undergo a complete cytoreduction. Certain patients will have an excellent response and may have the opportunity to subsequently undergo cytoreduction and HIPEC after downstaging. Some argue that even after complete cytoreduction and HIPEC, recurrence of these mucinous lesions is common, and adjuvant systemic chemotherapy is warranted. However, low-grade lesions are not classically responsive to systemic chemotherapy, and it is typically not recommended routinely. Conversely, chemotherapy may be considered for high-grade lesions and has some data to suggest improved progression-free survival.

N. Complete cytoreduction with HIPEC has become the preferred treatment for appendiceal lesions with concomitant peritoneal involvement (carcinomatosis, pseudomyxoma peritonei). Complete cytoreduction involves removal of all gross disease or reduction of tumor deposits to ≤2.5 mm in thickness. This is performed in conjunction with heated intraperitoneal chemotherapy (HIPEC). In addition, some surgeons perform an omentectomy, peritoneal and diaphragm stripping, and even removal of Glisson's capsule when involved. Bilateral oophorectomy may also be performed, especially in post-menopausal women. Tumor deposits on the small bowel may be resected or fulgurated. Intraperitoneal chemotherapy may be performed via an open or closed technique (Fig. 67.3). Mitomycin C (MMC) at a dose of 40 mg in 3 L of perfusate at 41–43 °C for 90 min (30 mg for 60 min with an additional 10 mg during 30 min). Floxuridine and 5-fluorouracil have also been used, but have demonstrated no benefit to date. Non-heated intraperitoneal chemotherapy (EPIC) for up to 7 days postoperatively via an implanted subcutaneous port may also be included. Recurrent disease is most often treated with repeat debulking or complete cytoreduction with additional HIPEC and has been reported result in long-term survival.

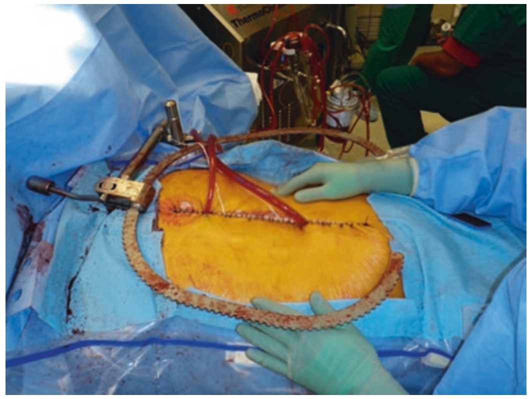


Fig. 67.3 Intraoperative photograph of heated intraperitoneal chemotherapy

O. Surgery is the primary treatment for most appendiceal neoplasms. Normally, only poor operative candidates, those with advanced or metastatic disease, or patients with a high PCI (*i.e.*, >20) who are not likely to undergo successful cytoreduction and HIPEC therapy are treated non-operatively. Somatostatin may be useful for metastatic carcinoid tumors, often with extensive liver involvement for symptomatic relief. Adjuvant chemotherapy may include 5-FU-based therapy alone or in combination with oxaliplatin or the monoclonal antibodies such as bevacizumab or cetuximab. While they play a role for epithelial neoplasms, they generally result in limited improvement in progression-free survival **(refer to section N in algorithm)**. Radiation therapy is rarely used in the treatment of appendiceal neoplasms.

Suggested Reading

AJCC American Joint Committee on Cancer. 8th ed. New York: Springer; 2017.

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Part VI

Small Bowel

Small Bowel Conditions: Small Bowel Crohn's Disease

68

Janet T. Lee and Wolfgang B. Gaertner

CD is a chronic unremitting inflammatory bowel disease usually characterized by patchy granulomatous inflammation of the entire bowel thickness that can affect any part of the gastrointestinal (GI) tract. The incidence of CD is 5–10 per 100,000 per year with a prevalence of 50–100 per 100,000. The peak age-specific incidence occurs between 10 and 20 years of age, and a second smaller peak occurs near age 50 years. Involvement of the terminal ileum and colon is the most common pattern (55%). Exclusive small bowel involvement is seen in 11–48% of cases, while involvement of duodenum, esophagus, stomach and mouth is uncommon and rarely occurs without concurrent disease in the small bowel or colon.

The pathogenesis of CD is unknown; however, it is believed to be associated with disrupted mucosal defense mechanisms caused by genomic mutations, leading to a dysregulated proinflammatory response to commensal gut bacteria. Studies have shown that mutations in the NOD2/CARD15 gene and the autophagy gene ATG16L1 are associated with CD. Despite this, CD-related genes account for less than one in four cases of CD. The pathogenesis of CD is most likely linked to changes in innumerable complex environmental factors as well. Of these, changes in intestinal microbiota and diet appear to be the most predominant. Other risk factors include family history of CD, Ashkenazi Jewish ancestry, living in an industrialized nation, and cigarette smoking.

Small bowel CD typically presents in three main behavior patterns: non-stricturing/non-penetrating, stricturing, and penetrating disease. Stricturing and penetrating types may be preceded by chronic inflammation and GI obstructive symptoms although many patients have a sentinel acute inflammatory episode that may be associated with an intra-peritoneal abscess or phlegmon requiring hospitalization. Fistula formation or development of an inflammatory mass or abscess is a feature of penetrating disease. Patients often require parenteral antibiotics, nutritional support with total parenteral nutrition, bowel rest, and percutaneous drainage if a large (>4 cm) and accessible abscess is present. Once this has resolved, the decision to optimize or escalate medical management *versus* elective operative management will depend on characteristics such as severity of symptoms, imaging findings including stricture, persistent fistula, as well as patient functional status and preference. Cases in which further medical therapy is unlikely to be successful include inability to control an infectious source, persistent bowel obstruction, suspicion of neoplasia, and presence of a chronic

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stricture. If elective operative treatment is indicated, our preference is to wait a minimum of 6 weeks after an acute inflammatory episode, when feasible.

Patients with CD commonly present with protein-caloric malnutrition and are often receiving immunosuppressive medications. A full history and physical, including previous and current medical and surgical treatments, history of tobacco use, a detailed anorectal exam, and nutritional assessment are highly recommended. Details regarding the initial diagnosis of CD including endoscopy and pathology reports should be reviewed. Most recent endoscopic and imaging reports should be reviewed as well, and discussed with the patient's primary gastroenterologist. Discussion of all cases of complicated CD at a multidisciplinary conference has been especially useful at our institution.

Duration and type of medical management is important to review in all CD patients that may require operative treatment. Medications including immunomodulators including azathioprine, and 6-mercaptopurine and biologic agents (infliximab, adalimumab, certolizumab, and natalizumab) have been associated with increased postoperative infectious complications in retrospective studies although this has not been proven prospectively. Many authors have recommended waiting 4–6 weeks from the last dose of these agents, when possible, before elective operative management. In our practice, we typically recommend waiting 2 weeks from the last dose of immunomodulators and 4 weeks from the last dose of anti-tumor necrosis factor (TNF) agents before elective bowel surgery.

Imaging studies such as MR enterography and CT enterography are useful in the preoperative setting to assess various degrees and extent of inflammation and presence of strictures or fistulas. An upper GI series with small bowel follow-through is especially useful in patients with upper GI involvement. The presence of a gastro- or entero-colic fistula is best evaluated with a contrast enema. Assessment of disease activity with endoscopy is very helpful as well and may be imperative in cases where ileocolic resection is proposed. The presence of dysplasia on endoscopic biopsies should be taken into account for both the extent of bowel resection and reconstruction. CD patients with confirmed malignancy should undergo appropriate preoperative staging and oncologic resection.

Refer to Algorithm in Fig. 68.1

Surgical treatment is required in approximately 70% of CD patients. Surgical principles that apply when operating for CD include: (1) Complete exploration of the abdominal cavity, (2) Assessment of the diseased bowel and adjacent structures, and (3) Preservation of all uninvolved bowel. The status and length of the entire small bowel and colon including the presence or absence of the ileocecal valve should be documented. Operative indications can be divided into acute disease complications, chronic disease complications, and failed medical therapy. Acute disease complications include hemorrhage, perforation, and severe enteritis/colitis; whereas chronic disease complications include stricture, fistula, and neoplasia or malignancy. The most common operative indications for small bowel CD are stricture and fistula. Failed medical therapy is the most common indication for operative treatment in patients with Crohn's colitis and can take several forms including unresponsive disease, incomplete response, medication-related complications, and noncompliance with medical therapy.

A. Severe and refractory inflammation of an isolated segment of small bowel is rare, as patients usually are affected by several stenotic segments of small bowel. Severe colitis with or without ileal involvement occurs in 4–6% of patients and is initially managed with physiologic resuscitation, nutritional support, broad-spectrum intravenous (IV) antibiotics, and medical therapy including IV steroids, immunomodulators, and biologic agents. Refractory disease, perforation, or worsening clinical course over the ensuing

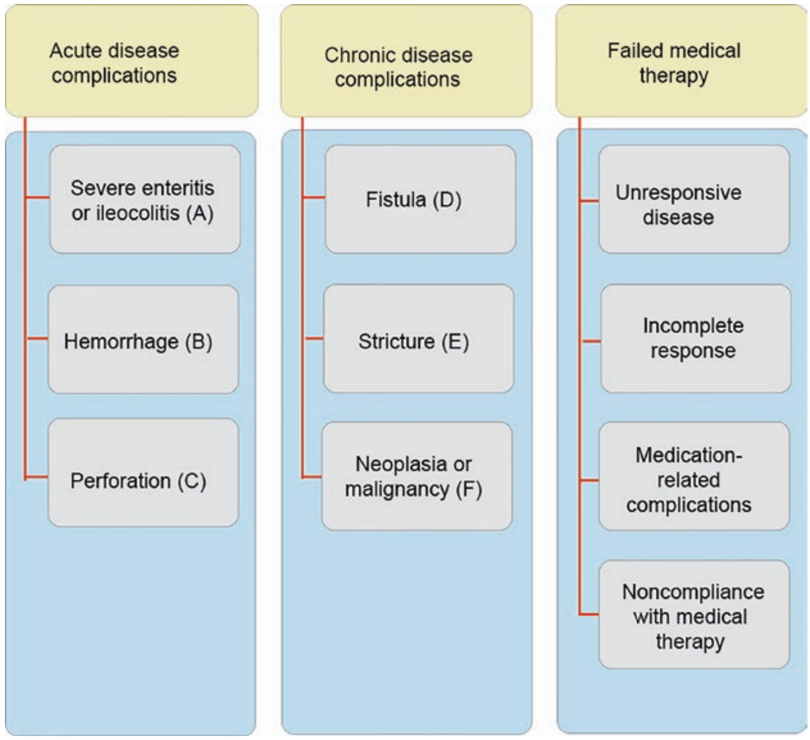

Fig. 68.1 Algorithm for operative indications for small bowel Crohn's disease

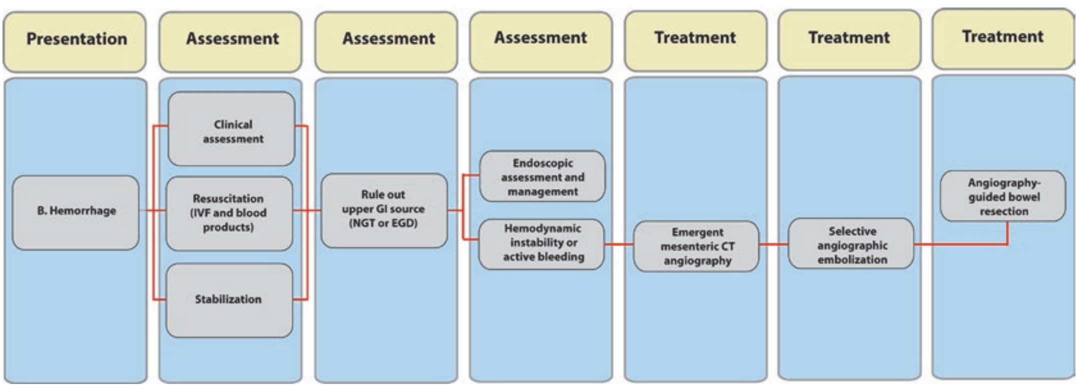

Fig. 68.2 Algorithm for management of gastrointestinal bleeding in Crohn's disease. *IVF* intravenous fluids, *NGT* nasogastric tube, *EGD* esophagogastroduodenoscopy

24–72 h requires surgical intervention. Operative treatment in this scenario commonly involves bowel resection with or without primary anastomosis depending on the presence of acquired immunosuppression from ongoing medical therapy, malnutrition, and severe inflammatory response, as well as disease location, extent and severity. Ileocolic involvement typically requires ileocolic resection with end ileostomy.

Refer to Algorithm in Fig. 68.2

B. Life-threatening hemorrhage from small bowel CD is uncommon. An upper GI bleed should be ruled out first with gastric aspiration or endoscopy. Management depends on the severity and persistence of bleeding, as well as the risk of recurrence. Localization of the bleeding is key. In a stable patient, endoscopic evaluation is preferable as it

allows for adequate assessment and therapeutic intervention. Patients who require ongoing resuscitation to maintain hemodynamic stability or have active bleeding from a small bowel source should undergo emergent mesenteric angiography to localize the bleeding source, and selective angiographic embolization in those who have a localized source. If this management option is not successful, the catheter is left in position and intraoperative angiography is performed to guide a limited bowel resection. Operative treatment is warranted for persistent hemodynamic instability, persistent bleeding despite 6 units of blood transfusion, and recurrent hemorrhage. Resection with or without anastomosis is usually required for ongoing hemorrhage. Intraoperative enteroscopy with endoscopic therapy may be preferable in less emergent cases.

Refer to Algorithm in Fig. 68.3

C. Perforation of the small bowel is uncommon and typically occurs at or just proximal to a stricture. Management requires resection with or without anastomosis. Resection margins should be conservative (2 cm) as only a grossly normal and not microscopically normal margin is necessary. Extent of disease can be difficult and is best assessed by digital palpation (and not by frozen section analysis) given that the earliest feature of luminal disease is mesenteric ulceration leading to mesenteric thickening (Fig. 68.4). Division of the affected mesentery can be difficult and is best managed with an overlapping clamp and suture ligature technique (Fig. 68.5), as energy devices that typically are used to divide mesentery may not seal vessels adequately. Perforation in the setting of ileocolic disease typically requires ileocecectomy. Primary anastomosis should be avoided with severe sepsis, malnutrition, and significant comorbidities.

D. There is a decreasing trend of small bowel fistulas in patients with CD, supposedly because of improved medical treatment as well as improved awareness of the disease. External fistulas can be enterocutaneous or perianal, and internal fistulas typically involve two segments of bowel but may involve other structures such as bladder, vagina, and retroperitoneum. Fistulas typically develop proximal to a stricture and are thought to be associated with transmural inflammation and increased luminal pressures. Only fistulas that are symptomatic require treatment. Symptomatic internal fis-

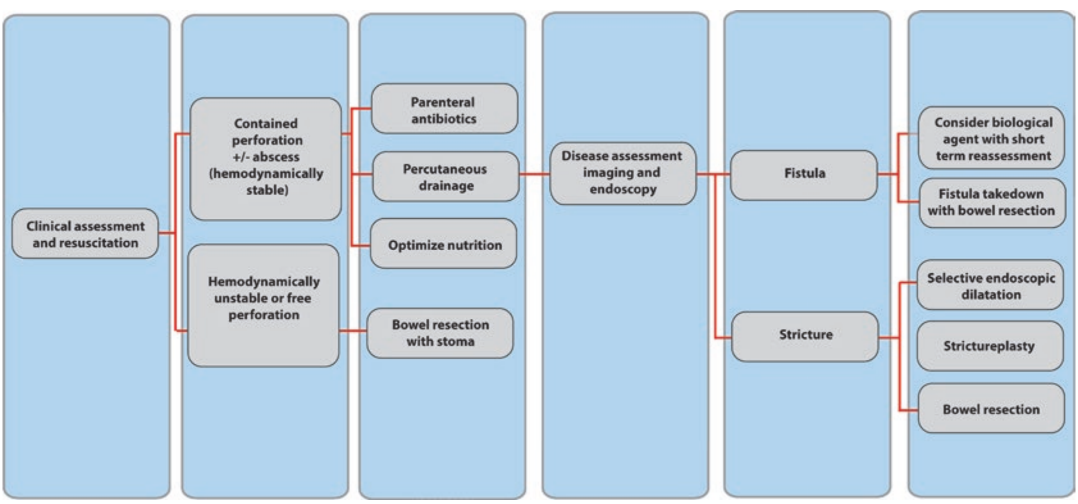

Fig. 68.3 Algorithm for management of bowel perforation in Crohn's disease

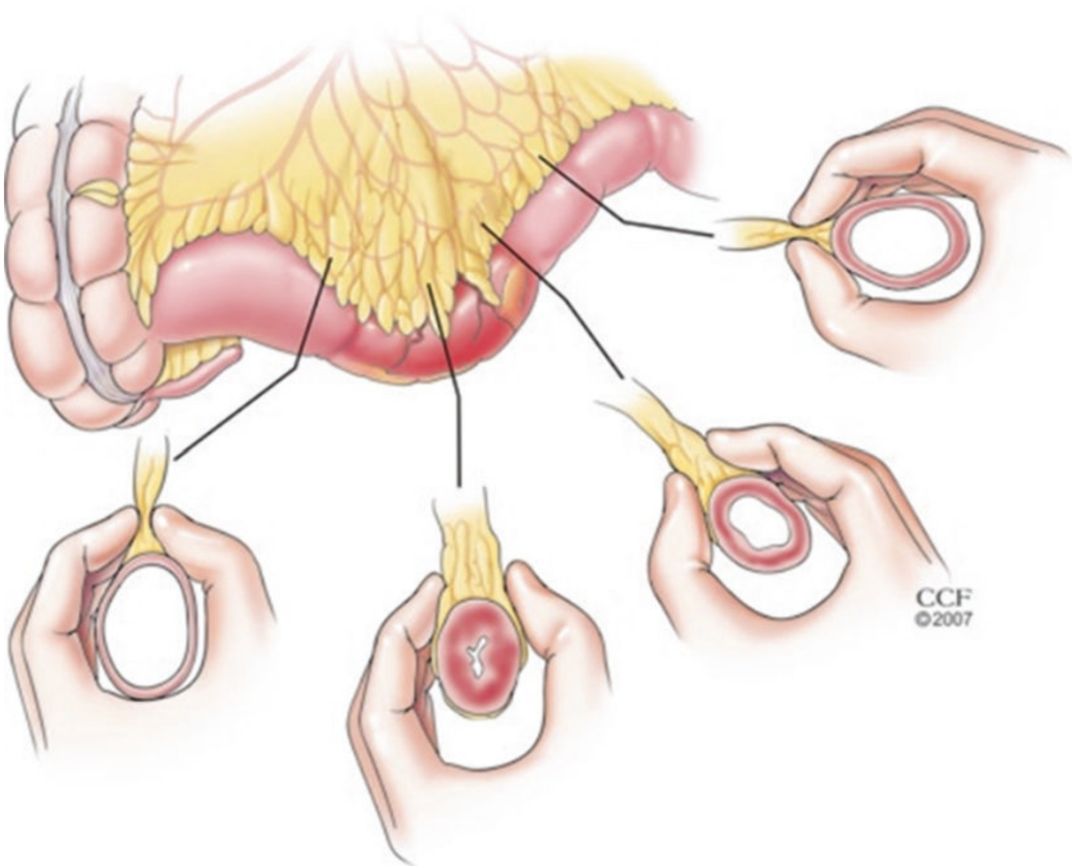

Fig. 68.4 Mesenteric thickness associated with intestinal disease. (With permission from Strong S. Crohn's Disease: Surgical Management. In: Beck DE, Roberts PL, Saclarides TJ, Senagore AJ, Stamos MJ, Wexner SD, eds. The ASCRS Textbook of Colon and Rectal Surgery 2nd ed. Springer, New York; pp.499–516.© Springer)

tulas most often bypass a long segment of bowel or are associated with persistent inflammation. Enteroenteric and ileosigmoid fistulas are the most common type of internal fistulas in CD with the majority originating at the terminal ileum. The majority of internal fistulas are best managed by resection of the diseased bowel, division of the fistula tract, and primary closure of the fistula site at the secondarily affected non-inflamed bowel.

Multiple studies, including a recent Cochrane review and small randomized controlled trials with limited follow-up intervals, have compared the outcomes of hand sewn end-to-end anastomosis and stapled side-to-side anastomosis in CD with comparable results with regards to anastomotic leak, anastomotic stricture, and disease recurrence. It is our preference to perform a stapled side-to-side anastomosis, using an 100-mm GIA stapler. After assuring hemostasis and off-setting the GIA staple-lines, the specimen with the common enterotomy is stapled-off with a TA stapler (90-mm). It is also our preference to reinforce the distal corner of the GIA staple line or "crotch", as well as the entire TA staple line with a running horizontal mattress absorbable suture, mainly for hemostasis.

Non-resectional procedures for CD depend on the site and extent of disease, and include internal bypass, external bypass or diversion, and strictureplasty. Occasionally, resectional and non-resectional procedures are combined.

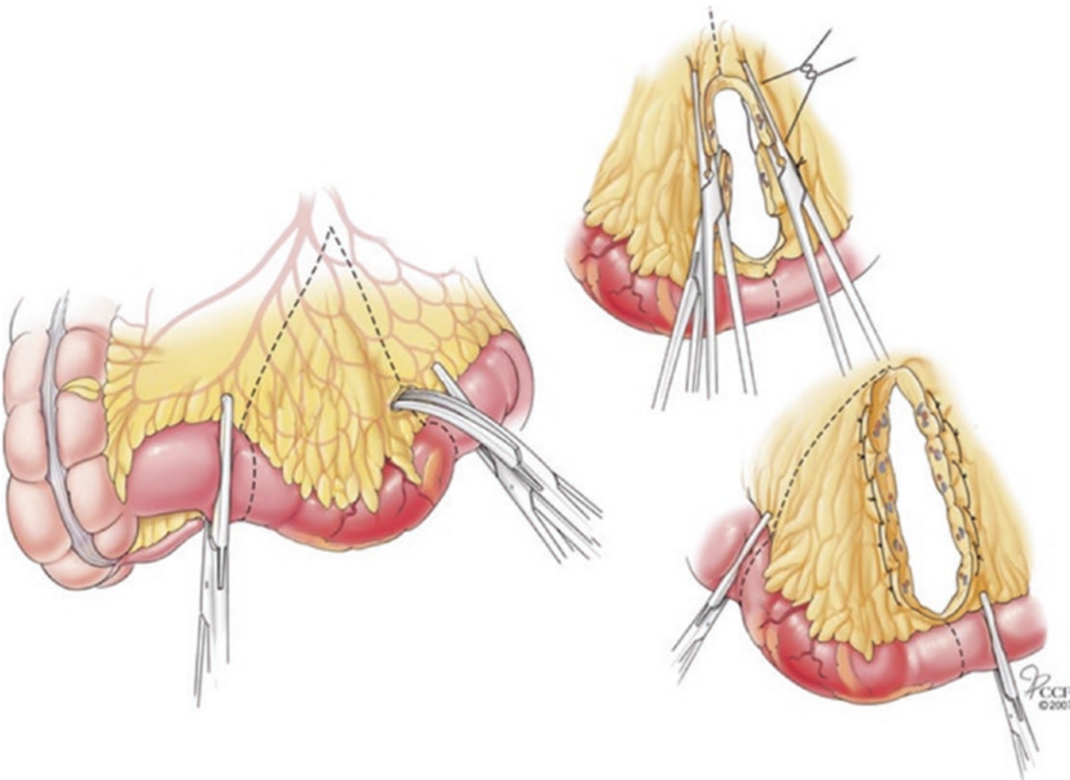

Fig. 68.5 Ligation of thickened mesentery. (With permission from Strong S. Crohn's Disease: Surgical Management. In: Beck DE, Roberts PL, Saclarides TJ, Senagore AJ, Stamos MJ, Wexner SD, eds. The ASCRS Textbook of Colon and Rectal Surgery 2nd ed. Springer, New York;pp.499–516.© Springer)

Resection with or without anastomosis is indicated in cases of multiple short-segment strictures or active disease, diseased bowel with fistula, perforation, abscess and phlegmon. Although internal bypass is currently performed much less frequently, this operation may be reasonable or even desirable in unique situations such as a phlegmon densely attached to retroperitoneal organs such as the pancreas and duodenum or to pelvic blood vessels. External bypass is performed with temporary or permanent stomas but should not allow for out-of-circuit bowel as it complicates further diagnosis and surveillance. Disease characteristics that commonly require external bypass include complex fistulizing disease and deep small bowel ulcerations that have penetrated into multiple abdominal organs or structures. Temporary diversion to heal distal disease, especially perforation, is typically not helpful.

E. Strictureplasty is a safe and effective alternative to bowel resection in view of the potential for recurrent operative resections resulting in short bowel syndrome. Situations for which strictureplasty may be considered include: (1) Symptomatic stricture without perforation, fistula, or concern for malignancy; (2) diffuse involvement of the small bowel with multiple strictures; (3) strictures in a patient who has undergone previous small bowel resection or who has short bowel syndrome; (4) rapid recurrence of CD with obstruction; and (5) malnutrition. A proximal diverting stoma should be strongly considered in patients undergoing multiple strictureplasties. Contraindications to performing a strictureplasty include severe inflammation, strictures associated with fistulas, abscess or phlegmon, and those with diffuse peritonitis secondary to perforation. Although it was originally thought that strictureplasty should

be avoided in a segment of bowel with active disease, recent studies have shown this to be feasible and safe.

The length of a strictured segment of bowel dictates the type of strictureplasty. Short (<10 cm) strictures are best managed with a Heineke-Mikulicz strictureplasty (Fig. 68.6), while long (10–20 cm) strictures should be corrected with a Finney strictureplasty (Fig. 68.7) or side-to-side isoperistaltic strictureplasty (Michelassi procedure) (Fig. 68.8). The Moskel-Walske-Neumayer strictureplasty is a variant of the Heineke-Mikulicz technique that is especially useful in strictures where there is a significant size mismatch between the dilated proximal and normal caliber distal small bowel (Fig. 68.9). A "Y"-shaped incision is made over the bowel and closed in a "V" fashion, which addresses the size discrepancy. Regardless of the technique, key principles of strictureplasty include an antimesenteric incision 1–2 cm beyond the diseased segment, biopsy of any suspicious mucosa such as an ulcer, nodule or polyp, and closure with absorbable suture material in a one- or two-layer fashion. A catheter with a balloon such as a Baker or Foley catheter may be passed through an enterotomy into the proximal and distal small bowel to diagnose additional strictures and assess the internal diameter. Alternatively, a 2.5 cm Bakelite ball can be inserted and passed through the small bowel up to the duodenum or down through the ileocecal valve to ensure all potentially symptomatic strictures are addressed.

Although endoscopic balloon dilatation is a safe and effective treatment for selective CD patients with de novo and anastomotic strictures, recent data has shown increased complication rates compared to previous reports. Studies with long-term follow-up have also shown that the majority of patients who undergo successful endoscopic dilatation require frequent re-dilatations and a significant number also require operative treatment. Furthermore, salvage surgery after failed endoscopic dilatation has been reported to be associated with increased adverse outcomes compared to strictureplasty or bowel resection first. Medical therapy is the mainstay of treatment for duodenal disease. Duodenal stenoses are typically unifocal and respond well to endoscopic dilation but require frequent repeat dilatations and many ultimately require operative treatment. Persistent duodenal strictures are treated with strictureplasty or bypass with a gastrojejunostomy.

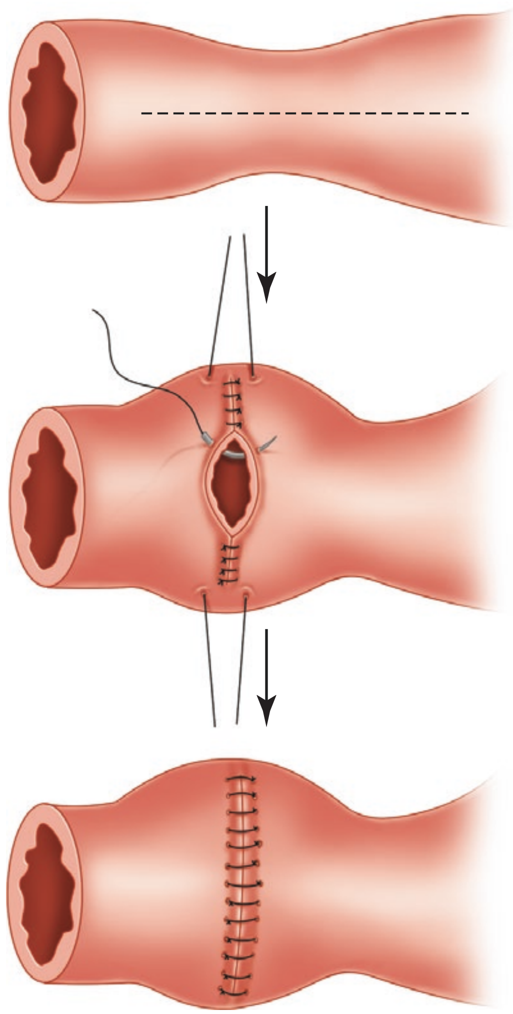

Fig. 68.6 Heineke-Mikulicz strictureplasty. (With permission from Muldoon R, Herline AJ. Crohn's Disease: Surgical Management. In: Steele SR, Hull TL, Read TE, Saclarides TJ, Senagore AJ, Whitlow CB, eds. The ASCRS Textbook of Colon and Rectal Surgery, 3rd Ed. Springer, New York, 2016;pp. 843–868 © Springer)

F. CD patients have a significantly higher relative risk of small bowel cancer and lymphoma,

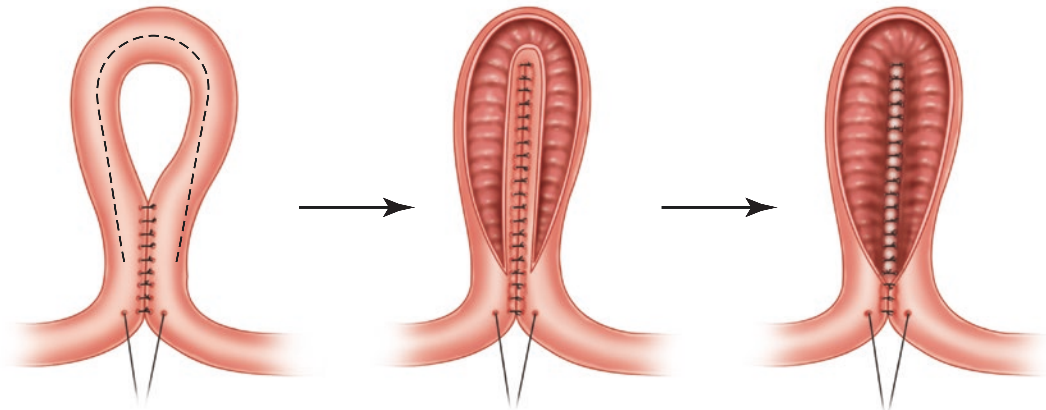

Fig. 68.7 Finney strictureplasty. (With permission from Muldoon R, Herline AJ. Crohn's Disease: Surgical Management. In: Steele SR, Hull TL, Read TE, Saclarides TJ, Senagore AJ, Whitlow CB, eds. The ASCRS Textbook of Colon and Rectal Surgery. Springer, New York, 2016;pp. 843–868 © Springer)

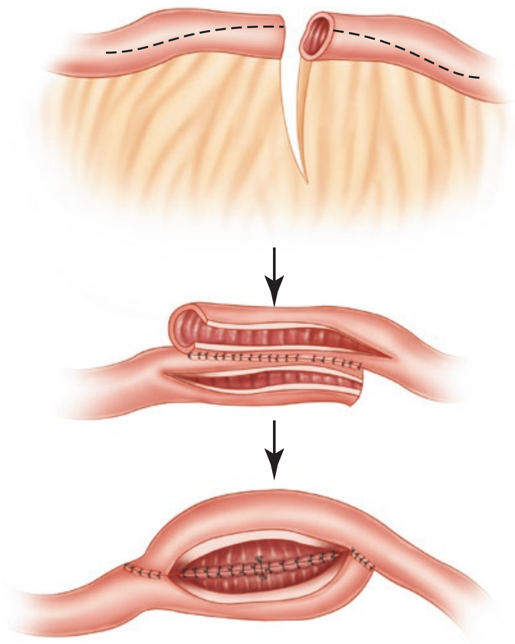

Fig. 68.8 Michelassi strictureplasty. (With permission from Muldoon R, Herline AJ. Crohn's Disease: Surgical Management. In: Steele SR, Hull TL, Read TE, Saclarides TJ, Senagore AJ, Whitlow CB, eds. The ASCRS Textbook of Colon and Rectal Surgery, 3rd Ed. Springer, New York, 2016;pp. 843–868 © Springer)

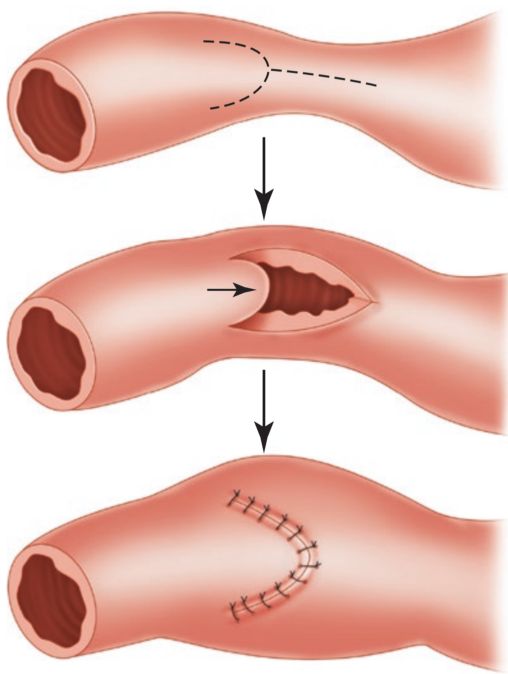

Fig. 68.9 Moskel-Walske-Neumayer strictureplasty. (With permission from Muldoon R, Herline AJ. Crohn's Disease: Surgical Management. In: Steele SR, Hull TL, Read TE, Saclarides TJ, Senagore AJ, Whitlow CB, eds. The ASCRS Textbook of Colon and Rectal Surgery, 3rd Ed. Springer, New York, 2016;pp. 843–868 © Springer)

with an 18.75-fold increase risk of small bowel cancer compared to the general population. Risk factors for cancer in CD include male sex, CD duration ≥20 years, bypassed or defunctionalized bowel, and stricture. Suspicion for malignancy should be adequately assessed with imaging and endoscopy with biopsies, when possible, to allow for appropriate medical and surgical oncologic treatment.

Although laparoscopic surgery for CD can be technically challenging, especially in the setting of penetrating disease and strictures, it has been associated with a reduced number of wound infections in small retrospective studies. A 2011 Cochrane review showed that laparoscopic surgery for small bowel CD was as safe as open operations and that there were no significant differences in perioperative outcomes or long term reoperation rates for disease-related or non-disease related complications of CD. Patients with hypotension and sepsis, extensive abdominal adhesions, a large inflammatory mass, and those who do not tolerate pneumoperitoneum should typically not undergo laparoscopic surgery.

Postoperative intra-abdominal septic complications are the most feared risks in CD patients. Large retrospective studies and meta-analyses have shown that steroid use, previous operative treatment, disease duration of >10 years, preoperative abscess, and low albumin levels are associated with a higher risk of postoperative septic complications. One study showed that positive histologic margins significantly correlated with postoperative septic complications. Postoperative abscess in a hemodynamically stable patient with no clear evidence of major anastomotic disruption can be managed with bowel rest, parenteral antibiotics and percutaneous drainage. However, patients with severe peritonitis or hemodynamic deterioration require operative re-exploration.

Postoperative recurrence is a feature of CD and is influenced by disease location, severity, disease-free interval, and medical treatment. Postoperative recurrence of CD is best evaluated with endoscopy. Endoscopic evidence of recurrence at 1 year is a predictive marker of clinical recurrence within 5 years. There are two strategies to prevent postoperative disease recurrence: (1) Initiate early postoperative treatment in an attempt to prevent future recurrence, and (2) wait for endoscopic recurrence before initiating aggressive postoperative treatment. Both 5-ASA preparations and anti-TNF agents have been shown to be superior to placebo for the maintenance of surgically-induced remission in patients with CD in small randomized studies. The potential benefit provided by 5-ASA drugs is modest with a number needed to treat of approximately 16–19 patients to avoid one relapse which raises issues about the cost-effectiveness of this therapy. The largest study on the role and impact of anti-TNF agents in preventing CD relapse after surgical resection is currently being evaluated in the multicenter randomized PREVENT trial. Despite aggressive approaches postoperative recurrence is ultimately inevitable in many CD patients; therefore, value-based efforts to avoid postoperative recurrence should focus on high-risk patients; including those patients who have had 2 prior intestinal operations, have perforating or penetrating phenotypes, and those who continue to smoke tobacco.

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Small Bowel Desmoid Disease

69

Jean H. Ashburn

Refer to Algorithm in Fig. 69.1

A. Desmoid tumors (DTs) are non-metastasizing growths of fibroaponeurotic tissue consisting of sheets of well-differentiated fibroblasts in a collagenous matrix. Although they are benign tumors without cytologic features of malignancy, their potential for aggressive behavior with relentless growth in confined spaces near high-risk structures make them potentially lethal. In patients with familial adenomatous polyposis (FAP) desmoid tumors develop most commonly in the abdominal cavity (50%), but can also occur in the abdominal wall (45%), and in the trunk or extremities (5%).

B. DTs are rare, with an incidence of approximately 2–4 cases per million in the general population. DTs have a strong association with familial adenomatous polyposis (FAP), a dominantly inherited disorder characterized by germ line mutations in the adenomatous polyposis coli (*APC*) tumor suppressor gene. Approximately 15% of patients with FAP will develop DTs (and another 15% will develop flat desmoid "sheet" lesions) usually after surgical trauma, and studies suggest a 1000-fold increase in the incidence of DTs in FAP patients compared to the general population. Desmoid disease (tumors and sheet lesions) is a significant contributor to morbidity and mortality in FAP patients. Desmoids are the second leading cause of death after colorectal cancers. Sporadic cases, unrelated to FAP, are typically found in extra-abdominal regions amenable to surgical resection but can be difficult to manage if they recur in inaccessible places.

C. The clinical behavior of DTs is unpredictable and poorly understood. Desmoid disease is a spectrum, ranging from firm tumors in the abdominal mesentery compressing adjacent structures to sheets of white plaques coating the small bowel mesentery, causing puckering and distortion of the adjacent bowel (Fig. 69.2). The latter has been termed 'desmoid reaction' or 'desmoid precursor lesion'. Desmoid tumors can exhibit swift growth causing symptoms from visceral compression or show slow, indolent progression without clinical symptoms. Chronic pain, intestinal obstruction, malnutrition, and development of enterocutaneous fistulae are possible complications. Spontaneous regression has also been noted in about 10% of cases.

D. DTs can be identified by physical exam, intraoperative identification, or radiographic imaging. Multidetector computed tomography (MDCT) and magnetic resonance imag-

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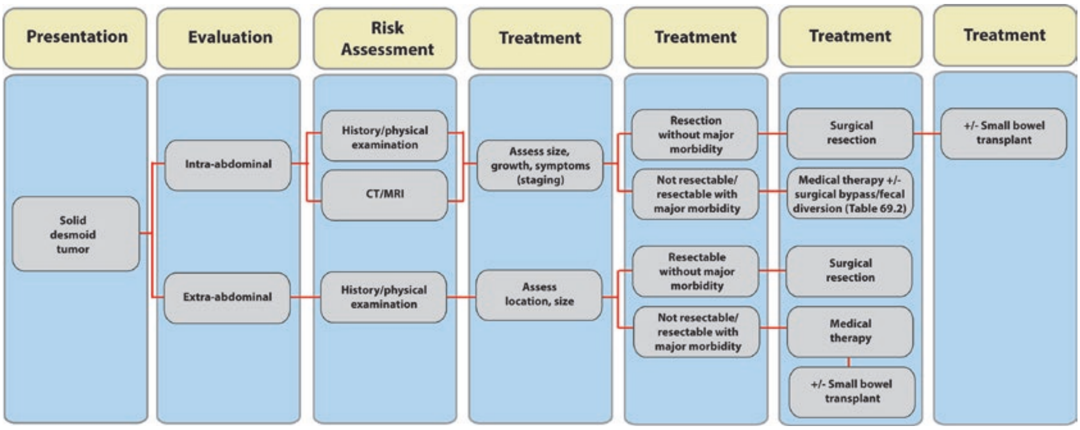

Fig. 69.1 Algorithm for small bowel desmoid disease

Fig. 69.2 Desmoid tumor arising in the mesentery of a pelvic pouch created after restorative procedure for FAP

Fig. 69.3 CT showing intra-abdominal desmoid tumor. Note the close proximity to mesenteric vessels

ing (MRI) of the abdomen and pelvis are mainstays of investigation, the latter having the advantage of avoiding radiation exposure. Both help to determine tumor size and demonstrate relationships to surrounding intestinal and urinary structures (Fig. 69.3). There is ongoing debate as to whether use of routine radiographic studies for preoperative assessment in patients with FAP should be performed. Patients in whom clinical suspicion of intra-abdominal desmoid disease (IAD) is low may avoid routine prospective investigation, as there seems to be little benefit. Patients with risk factors for IAD (personal or family history of DTs, specific gene mutations associated with DTs, female gender) may benefit from preoperative imaging to determine presence/extent of disease and help determine operative timing and strategy. PET-CT is not routinely used.

E. Desmoid disease associated with FAP tends to occur in the abdomen (50%) and abdominal wall (45%), and both locations can be difficult to manage. Abdominal DTs may be encasing or compressing mesenteric vessels, making resection hazardous with high risk of small bowel loss. Resection of those involving the abdominal wall can require complex fascial reconstruction with mesh. Although they can spontaneously occur, DTs are known to be associated with trauma (in particular

surgical trauma) and estrogen exposure (oral contraceptives, female gender), as well as certain types of *APC* mutations and family history of DTs. Risk for desmoid disease can be assessed with consideration of these factors, and abdominal surgery should be approached with caution in these patients.

F. The Collaborative Group of the Americas on Inherited Colorectal Cancer (CGA-ICC) proposed a clinically relevant, rational staging system in an attempt to standardize management of these unpredictable and poorly understood tumors. The system assigns a stage (I, II, III, IV) to each tumor based on its size, symptoms, and behavior (growth), and offers guidance regarding treatment and prognosis for each stage (Table 69.1).

G. There is no reliably effective medical therapy for desmoid disease and very little standardization of approach to therapy. Most treatments are based on small series of patients that have differing doses and combinations of medications. The CGA-ICC staging system has provided a structure for patients to be stratified according to severity of disease, and directs treatment options based on these characteristics. For uncomplicated disease (Stage I and II), sulindac and other NSAIDS are used in conjunction with anti-estrogen therapy. Stage I tumors are given no treatment or sulindac 150–200 mg twice daily. Stage II tumors are treated with sulindac and an anti-estrogen agent (tamoxifen up to 120 mg daily or raloxifene 120–240 mg daily). For more advanced tumors (Stage III and IV), cytotoxic chemotherapy is required for unresectable tumors that do not respond to sulindac and anti-estrogens. Most encouraging for these tumors is the chemotherapeutic combination of dacarbazine and doxorubicin, a common regimen given for sarcomas. Methotrexate and vinblastine is a less-toxic alternative. Radiotherapy is avoided due to the close proximity of desmoid disease to the intestine.

Table 69.1 CGA-ICC staging system for abdominal desmoid tumors

Stage	Description
I	Size <10 cm, no growth or symptoms
II	Size <10 cm, slow growth, mild symptoms
III	Size 10–20 cm, slow growth or moderate symptoms (bowel or ureteral obstruction)
IV	Size >20 cm, rapid growth or severe symptoms

Mild symptoms = sensation of mass/pain without restriction. Moderate symptoms = sensation of mass/pain with some restriction. Severe symptoms = sensation of mass/pain with severe restriction requiring hospitalization. Slow growth = <50% increase in maximum diameter within 6 months. Rapid growth = >50% increase in maximum diameter within 6 months

H. Surgery is the treatment of choice for uncomplicated, extraintestinal DTs unrelated to FAP. Resection is usually straightforward but recurrence is common (up to 50%). For DTs in the abdominal cavity, resection is risky due to association of tumors with the small bowel mesentery. Tumors adjacent to or surrounding mesenteric vessels are not amenable to resection, and surgery may result in catastrophic loss of intestine, massive hemorrhage, and high mortality. DTs located further away from the root of the mesentery or elsewhere in the abdomen may be resected without large loss of bowel but recurrence is common, even with R0 resection.

The approach to FAP patients with DTs or at high risk for DTs is more complex. Most desmoid disease in FAP occurs in response to surgical trauma, but surgical delay or avoidance is not possible in most FAP patients as untreated polyposis inevitably leads to colorectal cancer. There is a role for both total colectomy with ileorectal anastomosis (IRA) and restorative proctocolectomy with ileo-anal pouch (IPAA) in these patients. The morbidity associated with DTs does not differ whether they arise after IRA vs IPAA. IRA, in particular, is acceptable in patients who are candidates for rectal sparing surgery (low rectal polyp burden amenable to close endoscopic surveillance, desire to avoid complications of pelvic surgery). Despite initial fears, symptomatic desmoid disease after IRA is uncommon, lessened if a laparoscopic approach is used, and usually does not

preclude subsequent proctectomy with IPAA if desired after social and career goals are met.

I. Asymptomatic or unexpected DTs may be discovered after radiographic imaging for unrelated indications or during an abdominal exploration for FAP (or repeat explorations). Because of this risk, surgery is often delayed for patients in whom DTs are present or highly suspected, but this is not always necessary. If asymptomatic at the time of surgery, they are generally small or exhibit desmoid reaction without mass. When faced with the unexpected finding of DTs, studies have shown that the intended surgical procedure can usually be completed without difficulty. All incidentally discovered desmoid disease in FAP patients does not necessarily develop into clinically significant DTs over time, and routine surveillance abdominal imaging in FAP patients with incidental, clinically asymptomatic DTs is not indicated.

J. Enterocutaneous fistulae can develop as a result of ischemia and subsequent perforation of bowel adjacent to IAD. These fistulae are challenging to treat because of the mass effect of the DT itself, the risk of long-segment small bowel resection during surgery, extensive desmoid-associated adhesions, and lack of effective medical therapy to augment surgery. Surgical repair of these enterocutaneous fistulae may be considered but only after cautious patient selection, based primarily on whether radiologic review shows the utility of intestinal bypass or resection. Careful dissection is a must, with complete lysis of downstream adhesions, as much as possible, to avoid distal obstruction and further fistula formation. The most critical component of the surgical strategy is to have a 'bailout' plan ready in case the intended procedure must be aborted due to inadvertent or uncorrectable injury. This option may even involve a temporary or permanent stoma. One option is auto transplantation. In these settings, the small bowel is removed in its entirety to permit ex vivo desmoids resection. After complete extirpation of the desmoids, the bowel can be reimplanted with or without a vascular graft.

K. Small bowel obstruction is a common long-term complication of desmoid disease and is caused by direct effects of tumor on bowel, mesenteric margin, or vascular supply with ischemia. For mild, progressive symptoms, treatment is centered on symptom reduction with diet modification and reduction of tumor burden with medical therapy. Acute presentation or progression of symptoms despite medical therapy may be managed surgically, but with great caution. The offending DT may be resected if this is achievable. If this is not possible without great risk, an intestinal bypass may be created. If bowel is tethered due to mesenteric desmoid plaques, careful lysis may be performed, albeit with risk for perforation and devascularization. A stoma may be the best option if the above measures cannot be performed safely, or in conjunction with a downstream anastomosis.

L. Recommendations regarding pregnancy and use of oral contraceptives in female FAP patients at risk for DTs are controversial. The associations of DTs with female gender and their tendency to occur soon after pregnancy have driven the recommendation against pregnancy or oral hormone use in these patients. However, DTs occurring after a pregnancy have been shown to be less aggressive, smaller, and cause symptoms less frequently than those occurring in females never pregnant. These finding require confirmation prior to use in counseling the female FAP patient regarding pregnancy.

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Mesenteric Ischemia

70

Alexis R. Harvey, Alison R. Althans, and Anuradha R. Bhama

Refer to Algorithm in Fig. 70.1

A. Presentation
Although mesenteric ischemia is a rare cause of abdominal pain and hospital admission, mortality in acute cases can reach as high as 90%. Clinicians should have a high index of suspicion for this diagnosis in patients presenting with abdominal pain. Rapid onset of severe, diffuse abdominal pain is typical for acute mesenteric ischemia. In the earlier phases of the presentation, patients will present with "pain out of proportion" to physical examination. This pathognomonic physical examination finding is highly suggested of mesenteric ischemia. The presenting features of mesenteric ischemia vary between the different types, however, the cardinal feature in most cases is mid-abdominal pain that is seemingly much greater than other physical findings. Patients have a soft and non-distended or mildly distended abdomen, yet palpation results in marked tenderness that does not correlate to the otherwise benign appearance of the abdomen. The exception to this classic presentation is in patients with non-occlusive mesenteric ischemia who usually present with a history of hypotension or shock. With all types of mesenteric ischemia, as the ischemia worsens, the patient may develop symptoms of nausea, vomiting, heme-positive stool, and or diarrhea with or without red blood. Further progression may reveal an epigastric bruit, abdominal distension, guarding, rebound tenderness, decreased bowel sounds, and/or abdominal rigidity. Symptoms that are specific to types of mesenteric ischemia are denoted in Table 70.1.

B. Evaluation
Patients with suspected mesenteric ischemia should be promptly evaluated. All patients should be assessed for stability, placed on a monitor, and have adequate IV access so that fluid resuscitation can begin immediately. After initial evaluation of the patient's ABCs has occurred, then work up can proceed expeditiously. A high index of suspicion and thorough consideration of risk factors is critical to diagnosis. Risk factors for mesenteric ischemia include: cardiovascular disease (atrial fibrillation, recent acute myocardial infarction), recent abdominal or vascular sur-

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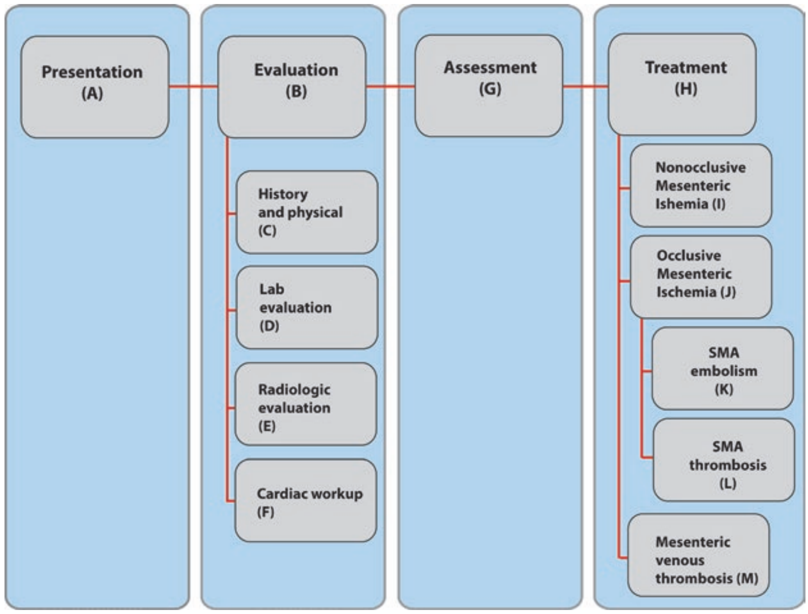

Fig. 70.1 Algorithm for mesenteric ischemia

Table 70.1 Signs and symptoms associated with subtypes of mesenteric ischemia

Type	Associated signs and symptoms
Nonocclusive mesenteric ischemia (NOMI)	Acute abdominal pain, nausea vomiting History of hypotension/shock
Acute mesenteric arterial embolism	Abdominal pain “out of proportion to exam” Nausea, vomiting, rectal bleeding
Acute mesenteric arterial thrombosis	Acute symptoms of abdominal pain, nausea vomiting, with history of post-prandial abdominal pain, “food fear”, weight loss
Mesenteric venous thrombosis	Diffuse, non-specific abdominal pain, nausea, vomiting

gery, hypercoagulable states, hemodialysis, peripheral artery disease, and certain medications. Evaluation should proceed with a thorough history and physical, laboratory work up, cardiac evaluation, and radiology assessment.

C. History and Physical Examination
Obtaining a thorough history is key to diagnosing mesenteric ischemia and identifying the underlying etiology. Signs and symptoms of mesenteric ischemia are generally sudden in nature, though some patients may provide a history suggestive of ongoing chronic mesenteric ischemia such as postprandial pain and weight loss. It is important to obtain a detailed history of cardiovascular disease—with particular attention paid to a history of arrhythmias, diffuse atherosclerotic disease, personal and/or family history of thrombophilia or hypercoagulable conditions, coexisting conditions such as inflammatory or oncologic disease, recent trauma, and recent surgical history. These factors will allow the clinician to correctly diagnose the type of mesenteric ischemia and formulate an appropriate treatment plan.

D. Laboratory Evaluation
The evaluation for mesenteric ischemia requires blood laboratory studies. It is important to note that there are no pathognomonic findings for mesenteric ischemia. Blood work should include: a complete blood count (CBC), a comprehensive metabolic panel (CMP), lactic acid, nutrition labs, possible arterial blood gas (ABG), and possible assessment for hypercoagulable state. A CBC may reveal leukocytosis and hemoconcentration. CMP, ABG, and lactic acid may demonstrate a metabolic acidosis in the case of advanced ischemia. Coagulation parameters (PT/PTT/INR) should be obtained to assess patients’ anticoagulation status if on

warfarin. An ABG should be obtained in any patient that is unstable from a respiratory standpoint, but can be omitted in stable patients. Markers of nutritional status: albumin, prealbumin, transferrin, and C-reactive protein may be utilized to establish nutritional status prior to treatment. It may be necessary to perform a thorough workup for hypercoagulable state if suspicion exists, though this may be deferred until the patient has been stabilized. This includes tests for protein C and S levels, antithrombin III level, lupus anticoagulant, and anticardiolipin antibody. It is also important to remember that elevated lactate may be a late finding.

E. Radiologic Evaluation
The majority of radiologic studies are also non-specific and largely non-diagnostic in the evaluation of mesenteric ischemia, including plain abdominal radiographs, ultrasound, computed tomography, and angiography. Plain abdominal X-ray may reveal bowel dilation, pneumatosis intestinalis, or free air in the case of free perforation. Computed tomography angiography (CTA) has been established as a useful imaging study for both rapid and accurate diagnosis of mesenteric ischemia with an accuracy of around 95%. Both arterial and venous phases may be utilized to assess all of the relevant vasculature, identify an embolic source, and visualize associated bowel pathology such as bowel wall edema and thickening=. In cases of SMA thrombosis, there may be visible calcium deposits at the origin of the vessel and the occlusion occurs 1–2 cm from the takeoff of the vessel from the aorta. A meniscus sign within the SMA may be indicative of embolism. Other findings may include pneumatosis intestinalis or portal venous gas, which are both signs of potentially threatened bowel. If there is a perforation, pneumoperitoneum and free fluid is seen throughout the abdomen. Conventional angiography had traditionally been considered the gold standard for diagnosis, but is now implemented only when CTA findings are equivocal or endovascular treatment is under consideration. In patients who are unable to receive IV contrast dye due to renal insufficiency, a duplex ultrasound may be obtained, which has a sensitivity and specificity between 85 and 90%.

F. Cardiac Evaluation
All patients should under to an EKG to evaluate for arrhythmia. Embolism accounts for approximately 50% of cases of acute mesenteric ischemia and investigation to identify a source of thrombus should be investigated. Patients with atrial fibrillation who are either not on anticoagulation or have sub-therapeutic levels of anticoagulation may develop intracardiac thrombus as the source of embolism. These patients should undergo transthoracic echocardiogram and also transesophageal echocardiogram as indicated.

G. Assessment (Table 70.2)
With a high-degree of suspicion, a rapid evaluation should allow accurate clinical diagnosis of mesenteric ischemia and proceed with classification of the type of ischemia. The type of ischemia is designated by the underlying etiology of the vascular insufficiency.

As stated, mesenteric ischemia can be subdivided into four types: (1) Nonocclusive

Table 70.2 Etiology and Risk factors of subtypes of mesenteric ischemia

Type	Etiology/Risk factors
Nonocclusive mesenteric ischemia (NOMI)	Low-flow state results in hypoperfusion to intestine i.e.: shock, hypovolemia, acute coronary syndrome, hypotension, use of vasopressors.
Acute mesenteric arterial embolism	Typically cardiac origin. Risk factors: include myocardial infarction, arrhythmias, valvular disease, endocarditis, cardiomyopathy, ventricular aneurysm May occur during angiography if local atheromatous plaques to be dislodged
Acute mesenteric arterial thrombosis	Preexisting atherosclerotic disease at origin of the SMA acts as nidus for thrombus during low flow state
Mesenteric venous thrombosis	Results when a patient has a risk factor for venous stasis, vascular injury, or hypercoagulability.

mesenteric ischemia (NOMI), (2) Acute thrombosis of mesenteric arteries, (3) Acute embolism of mesenteric arteries, and (4) Mesenteric venous thrombosis. The previously discussed evaluation allows for differentiation of these varied etiologies, which then drives treatment strategy.

Nonocclusive mesenteric ischemia accounts for ~20% of cases of this disease and presents in patients who have experienced a hypotensive episode. The hemodynamic instability results in a low flow state and malperfusion of the intestines. This problem can occur in patients who have experienced acute cardiac syndrome, found unresponsive due to intoxication or trauma, experienced severe episodes of sepsis, severe dehydration, massive hemorrhage, or even severe diarrhea. The abdominal pain correlates to the patient's hemodynamic status. This diagnosis is made largely by history and physical examination. CT scan typical demonstrates patent vessels (though there may be signs of hypovolemia, such as collapse of the IVC) and possible bowel wall thickening and edema.

Acute thrombosis of mesenteric arteries, most often the superior mesenteric artery, occurs in patients who have a known history of peripheral vascular disease with diffuse atherosclerosis and known pre-existing stenosis of the SMA. Approximately 20% of cases of mesenteric ischemia are due to SMA thrombosis. These patients present with a history of typical postprandial pain with possible weight loss. Acute thrombosis can occur when there is a low-flow state resulting in stasis and thrombosis in the setting of an already occluded vessel. This diagnosis is demonstrated on CTA of the abdomen demonstrating calcification at the root of the vessel with a thrombus a few centimeters distal to the takeoff of the vessel of the aorta. Often, this diagnosis is made intraoperatively as thrombosis of the SMA presents with occlusion of the first jejunal branch of the SMA, resulting in ischemia of the proximal small intestine.

Acute embolism of the SMA also presents with acute abdominal pain, but is typically in the setting of a patient with an arrhythmia. These patients often have atrial fibrillation, either preexisting or new onset, seen on EKG. When these patients are not therapeutically anticoagulated, a cardiac thrombus can develop resulting in embolism to the peripheral vessels. Because of the high flow rate of the SMA, emboli frequently travel to this vessel and lodge 3–10 cm past the origin off the aorta. These patients present with acute abdominal pain and pain out of proportion to exam. CTA of the abdomen may demonstrate a meniscus sign within the SMA with contrast flowing up to the point of embolism with a lack of contrast flow distally. Intraoperatively, this diagnosis can be made by visualizing sparing of the proximal small intestine and left colon as the embolus lodges distal to the takeoff of the middle colic artery and first jejunal branch of the SMA.

Mesenteric venous thrombosis accounts for approximately 10% of cases of mesenteric ischemia. This entity also presents with abdominal pain, but symptoms are usually vague with nausea, vomiting, diarrhea, and diffuse abdominal pain and cramping. Typically, this is not a hyper-acute presentation given the ambiguity of abdominal symptoms. Diagnosis is usually made on CT scan demonstrating a filling defect in the venous phase. The inferior mesenteric, superior mesenteric, splenic, and portal veins are potentially involved sites of thrombosis. The SMV is the most common site of thrombosis. A vascular outflow obstruction leads to edema and ischemia of the intestines. These patients frequently have an underlying hypercoagulable state, cancer, or have undergone some sort of pancreas or colon resection. When severe, mesenteric venous thrombosis can result in necrosis to the intestine, and has a unique dark black/purple appearance on exploration.

H. Treatment

All patients with any suspicion for any type of mesenteric ischemia should be immediately evaluated at the bedside. IV access is imperative and fluid resuscitation should begin immediately. All patients should ini-

tially be kept NPO and broad spectrum IV antibiotics should be administered. Antibiotics should cover gut flora (gram negative bacteria and anaerobic bacteria) as bacterial translocation to the blood stream is possible in the setting of ischemic bowel (e.g., floxin and metronidazole). Therapeutic anticoagulation with a heparin drip should also be initiated once the diagnosis is made. Patients in whom bowel ischemia is not suspected should be admitted for close observation. Any patient who presents with acute peritonitis, perforation, or have any evidence of bowel infarction should be taken to the operating room emergently regardless of underlying etiology. Resuscitation should immediately begin and continue prior to and during the operation. During laparotomy, any frankly necrotic bowel should be resected (Fig. 70.2). Further treatment then proceeds based upon the patient's underlying condition and the suspected underlying etiology.

Patients should be counseled as to the morbidity and possible mortality associated with this diagnosis. Restoration of blood flow to the intestines does not ensure patient survival. In some cases, there is suspicion that the entire small intestine has infarcted. Ischemia of this severity would require resection of a majority of the small intestine, which is not compatible with life. In these cases, palliative measures may be discussed with the patient's decision makers.

I. Nonocclusive Mesenteric Ischemia

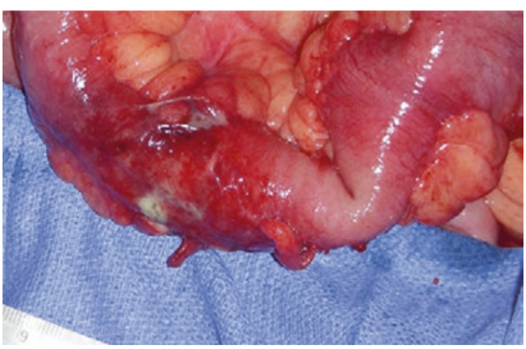

Fig. 70.2 Ischemic ileum from an embolic event

Patients with suspected nonocclusive mesenteric ischemia should be conservatively treated and rarely require operative intervention. Resuscitation with intravenous fluids should begin immediately along with broad spectrum antibiotics. Serial abdominal exams are essential to evaluate for any acute deterioration in clinical status. Serial blood work may also be checked, including serial lactate, though as stated, laboratory values are not always indicative of bowel infarction. Some patients, with severe comorbid conditions, may experience bowel infarction due to nonocclusive mesenteric ischemia and require operation. These patients often have concerning examination findings with worsening labs and potential development of multisystem organ failure. Exploration should immediately occur once the suspicion of bowel infarction arises. If there is no concern for impending bowel infarction, patients should respond to resuscitation and antibiotics. These patients also require therapeutic anticoagulation in order to prevent thrombosis from occurring. In severe cases, patients should be evaluated for catheter-directed injection of vasodilators such as papaverine. These patients can be evaluated for vasospasm by angiography and effectiveness of vasodilators can be confirmed via angiography as well.

J. Occlusive Mesenteric Ischemia
Occlusive mesenteric ischemia requires operative restoration of blood flow. Initial resuscitation with intravenous fluids and antibiotics should be initiated immediately and ongoing while patients are prepared for the operating room. These patients should be taken to the operating room emergently for assessment of bowel viability and vascular intervention.

K. Patients who are suspected to have SMA embolism should be emergently taken to the operating room with active resuscitation ongoing. A laparotomy is performed and the abdomen is explored. Any obviously necrotic or perforated bowel should be resected, while bowel that is questionable may remain *in situ* while attempts are made at restoring blood flow. The ligament of Treitz is identified and transected to expose the SMA. Exposure is the key to this step, either

directly or with medial visceral rotation. Proximal and distal control should be obtained in the standard fashion. Using embolectomy balloons, an embolectomy should be performed proximally and distally. The arteriotomy is closed using a vein patch, bovine pericardium patch, or Dacron. If restoration of blood flow is not successful, then a bypass can be performed. After blood flow is restored, the viability of the questionable bowel should be reassessed. Any necrotic bowel should be resected, but if there are segments of bowel that appear potentially viable, a second look laparotomy can be performed in 24–48 h with a temporary negative-pressure dressing placed in the interim to close the abdomen. It is important to be cognizant of the potential for reperfusion injury.

L. SMA thrombosis is also treated with restoration of blood flow and a bypass is often required as the native vessel is usually chronically diseased. Options for bypass include supraceliac aorta, infrarenal aorta, or iliac artery. The supraceliac aorta provides an antegrade flow to the SMA, while the infrarenal aorta and iliac artery provide retrograde flow. In choosing an operative approach, it is important to assess the native vessels for atherosclerotic disease. The saphenous vein is the conduit of choice, though Dacron or polytetrafluoroethylene (PTFE) may be used in situations where saphenous vein is not available. The complexities of vascular reconstruction are beyond the scope of this chapter. Similar to SMA embolism, it is important to resect any frankly necrotic or perforated bowel. Marginal bowel may be left in situ while revascularization is performed with reassessment after restoration of blood flow. A second look laparotomy can be performed in the ensuing 24–48 h with a temporary abdominal closure in the intervening time period.

M. Venous Thrombosis

Venous thrombosis usually does not require operative intervention unless there is concern for necrotic bowel. Bowel resection should be performed if indicated as thrombectomy has not been shown to improve outcomes. Patients should be evaluated for hypercoagulable states while therapeutic anticoagulation is initiated. In the initial stages, patients should be anticoagulated with a heparin drip (80 units/kg bolus followed by 18 units/kg/hr. infusion). Patients who continue to experience persistent abdominal pain may be candidates for catheter directed thrombolysis. Specific techniques of endovascular treatment are beyond the scope of this chapter. Interventional radiology and vascular surgery should be involved in the care of these patients. If these services are not available, the patient should be transferred to a tertiary care center without delay.

Conclusion

Mesenteric ischemia is a potentially life threatening condition that should be evaluated and treated in a rapid fashion. Four types of mesenteric ischemia occur and a combination of history, physical examination, and radiologic evaluation are critical to determine the underlying etiology, as treatment is vastly different based upon etiology. Resuscitation, anticoagulation, and antibiotics should begin without delay and operative intervention should be performed in an emergent manner. A multidisciplinary approach with the involvement of general surgery, vascular surgery, and interventional radiology will result in best outcomes for patients with this potentially morbid condition.

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71 Small Bowel Conditions: Small Bowel Obstruction

James P. Taylor and Jonathan E. Efron

Refer to Algorithm in Fig. 71.1

A. **(Presentation)** Small bowel obstruction (SBO) accounts for nearly 20% of surgical admissions for acute abdominal pain in the United States. Classical symptoms include colicky abdominal pain, nausea, emesis, abdominal distension and possibly diarrhea. The presentation can vary depending upon the severity of the obstruction (complete vs. partial), the anatomic site of the obstruction (proximal vs. distal) and the elapsed time between onset and presentation. A variety of pathology can lead to SBO, with the obstructing lesion being either intraluminal (intussusception or gallstone), intramural (neoplasm or Crohn's disease), or extrinsic (adhesions or hernia) in nature. Mortality after surgery for SBO ranges from 2 to 8%, though this can rise to as high as 25% if surgical intervention is delayed.

B. **(H&P)** A focused history and physical examination can often elucidate the diagnosis of SBO, although the specific etiology may require adjunct investigations including imaging and laboratory tests. Patients can present at any age due to the variety of pathology that can obstruct the small bowel, although most commonly in the United States patients are aged over 50 years and have had prior abdominal surgeries resulting in adhesion formation. Classic examination findings include localized severe abdominal pain, distension and high-pitched 'tinkling' or absent bowel sounds. A short period of time between onset of symptoms and presentation to the emergency department raises suspicion of a closed-loop obstruction. Likewise, a complete obstruction often presents more acutely and with greater severity than a partial obstruction. Another key factor that can aid diagnosis and management is the characteristic of the patient's vomitus, particularly if it is feculent in nature, as this suggests a more distal and long-standing obstruction. Patients with abdominal pain and bowel obstruction are concerning. In these patients pain may be indicative of either distension or ischemia. If the pain does not resolve with NGT decompression, the surgeon should have a high suspicion for persistent ischemia and proceed to surgery.

C. **(Radiology)** Patients who present with signs and symptoms of SBO will undoubtedly receive a radiological study of some description. Plain abdominal radiographic findings of dilated small bowel loops (greater than 3 cm), air fluid levels on an upright film and reduced colonic gas all suggest SBO, though

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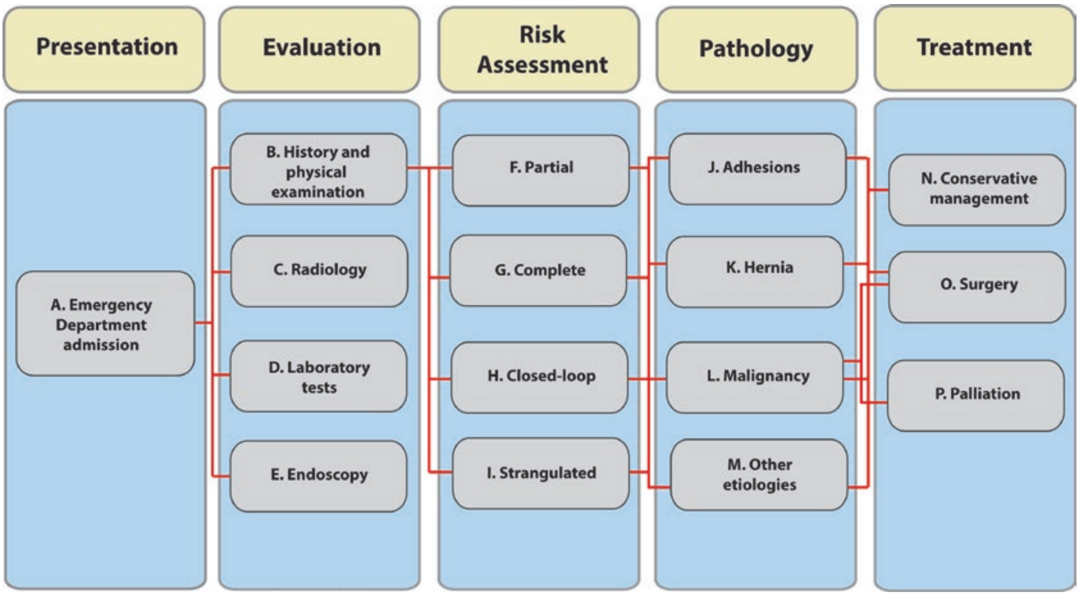

Fig. 71.1 Algorithm for evaluation and management of Small bowel obstruction (SBO)

the accuracy of this modality is poor. An erect chest radiograph can be of use to detect the presence of free intra-abdominal air in the acutely unwell patient. CT scan with IV contrast has a far greater sensitivity and specificity for detecting SBO than plain radiographs. More importantly, CT scans have the advantage of being able to provide a likely diagnosis of the cause of the obstruction, especially in the case of hernias, masses and intussusception. A further benefit is the ability to detect radiological signs of bowel strangulation and ischemia, including bowel wall thickening, pneumatosis intestinalis and mesenteric engorgement. Further studies, particularly in the post-operative or chronic setting, include the use of oral contrast to enable luminal visualization. CT enterography, enteroclysis and small bowel series can all be of benefit in identifying obstructive lesions; however, they are contraindicated in the acutely unwell patient or those with complete obstruction or suspected perforation.

D. **(Lab Tests)** No specific laboratory tests will enable the diagnosis of SBO to be made independently, however they can be useful in assessing the severity and the need for emergent surgery. A CBC may reveal leukocytosis indicative of an inflammatory or infective process, and in the case of strangulation resulting in bowel ischemia there may be elevated serum D-lactate, amylase and intestinal fatty acid binding protein. For patients with suspected malignancy or carcinomatosis, tumor markers may aid in revealing the origin of the lesion, although this is not of much use in the acute setting.

E. **(Endoscopy)** Endoscopy is generally contraindicated in cases of SBO, however it can be selectively utilized for specific etiologies of small bowel obstruction. Most notably endoscopy plays a role in the management of pediatric cases of intussusception, where it can fulfill both a diagnostic and interventional role, and it is also of utility in SBO caused by proximal obstructing lesions affecting the distal stomach or duodenum. In the latter situation, the endoscope can either dilate or stent the affected region and this strategy is often employed when planning, or bridging, for definitive surgery.

F. **(Partial)** SBO can manifest in a variety of manners and a detailed history can help delineate the nature of the bowel obstruction.

Partial SBO, otherwise known as low-grade SBO, refers to the situation where the bowel lumen is narrowed, however there is still some passage of bowel contents beyond the restricted region.

G. **(Complete)** In comparison complete, or high-grade SBO occurs when the bowel lumen is completely occluded and as a result no stool or air is permitted to pass.

H. **(Closed Loop)** If the bowel is obstructed distally, it should be possible to decompress the bowel through either emesis or the insertion of a NGT; this is referred to as an open-loop obstruction. When the bowel is obstructed at both a proximal and distal location along its course, the isolated segment continues to secrete fluid and progressively dilate. This setting is referred to as a closed-loop obstruction and can result in impaired venous return or obstructed arterial flow, subsequently progressing to bowel ischemia. Patients typically incur greater pain with a closed-loop obstruction and significantly, the pain is not relieved by decompression with NGT or emesis. The etiologies that most commonly result in a closed-loop obstruction include intestinal torsion or incarceration of bowel within a hernia sac. Classic CT findings of a closed-loop obstruction include a “U”, “C” or “coffee bean” configuration of bowel, however this is dependent upon the plane of imaging.

I. **(Strangulated)** A simple hernia is one in which the blood supply to the bowel is intact, whereas when the blood supply is compromised the term ‘strangulated’ is utilized. Ischemia of the bowel results in significantly higher rates of mortality, with reports in the literature of patients undergoing surgery for SBO with ischemia reaching as high as 25%. In comparison, surgery for simple SBO carries a mortality rate of approximately 2%. When the bowel is strangulated, surgery should be performed immediately. Typical CT findings that should raise suspicion of ischemia include bowel wall thickening greater than 3 mm, mesenteric edema, abnormal bowel wall enhancement, fluid within the mesentery or peritoneal cavity, and engorged or occluded mesenteric vessels. Later findings comprise pneumatosis, and mesenteric or portal venous gas. Conditions that can lead to strangulated bowel are often those that predispose to closed-loop obstructions.

J. **(Adhesions)** The most common cause of SBO in the Western Hemisphere is post-operative adhesions, accounting for nearly 75% of all cases. Adhesions can develop in up to 30% of patients, depending upon the initial surgery performed. Within the United States greater than 300,000 patients are admitted for adhesiolysis procedures on a yearly basis, with the success of the procedure limited—nearly a third of patients develop a recurrent SBO and require re-operation.

K. **(Hernia)** Hernias are the second most common cause of SBO, with both external and internal herniation of the bowel potentially compromising the caliber of the lumen. Most importantly, herniation of a segment of bowel can result in a closed-loop obstruction, precipitating bowel strangulation and perforation. Hernias can be sub-divided into those that are reducible and those that are not, otherwise referred to as an incarcerated hernia. It is common practice to attempt to reduce an external hernia in a patient who presents to the emergency department with signs of bowel obstruction, as this can potentially assist in relieving the symptoms. However, it is important to take a full history and carefully examine the patient to determine the duration of incarceration and to assess for the presence of threatened bowel. If there is overlying skin erythema and the patient appears septic or hypotensive, then reducing the hernia can result in the release of inflammatory cytokines that can lead to rapid destabilization, hence immediate surgical exploration should be mandated.

A thorough surgical history is vital in a patient presenting with SBO to explore the possibility of an internal hernia as the causative pathology. A common example is

patients with a history of Roux en-Y gastric bypass, where the presence of pain and CT evidence of internal hernia should mandate surgical exploration.

L. **(Malignancy)** Metastatic disease within the abdominal cavity has the propensity to predispose to SBO, with melanoma and ovarian metastases far more common than primary neoplasm as the inciting pathology. When a patient with no prior surgical history presents with SBO, then malignancy should be at the top of the differential list. A CT scan can aid in providing important diagnostic information to help distinguish intra-abdominal malignancy from other potential etiology and subsequently help to guide management appropriately.

M. **(Other Etiologies)** Numerous additional pathologies can result in the formation of SBO, which highlights the importance of a thorough history, physical examination and the importance that adjunct laboratory and radiological investigations can play in the workup. Crohn's disease, intussusception, Meckel's diverticulum, abscesses, gallstone ileus, volvulus, traumatic hematoma, radiation enteritis, bezoar, congenital anomalies and superior mesenteric artery syndrome are less common, but highly significant causes of SBO.

N. **(Conservative Management)** Patients that lack the concerning factors suggestive of strangulated bowel or closed-loop obstruction warrant an initial trail of conservative, or non-operative, management. This includes the insertion of a NGT, aggressive IV fluid resuscitation, correction of electrolyte abnormalities, pain management and serial abdominal examination. This approach has historically referred to as "drip and suck" and requires acute clinical judgment to identify failure of response.

   Intraluminal distension can result in ischemia of the bowel mucosa, thus highlighting the importance of an NGT in non-operative management. In addition to the benefit of relieving pressure and preventing ischemia, the NGT aids in the assessment of SBO resolution, as decreased output is suggestive of return of antegrade bowel function. Many physicians opt to perform 'clamp trials', where the residual volume is recorded every four hours after disconnecting the tube from a drainage system. Residuals of less than 200 ml over two consecutive trial periods are typically used as guide for removal of the tube.

   Patients typically present with hypochloremic, hypokalemic metabolic acidosis secondary to repeated emesis. Aggressive fluid resuscitation and correction of the electrolyte imbalance are important to prevent any potential sequela. A urinary catheter should be placed to assist in monitoring the adequacy of resuscitation.

   Pain control is an important and highly debated consideration in the management of SBO. Narcotic pain medications in particular have been criticized for not only masking the signs of worsening bowel obstruction, but also for potentially exacerbating the condition. A patient controlled analgesia device is suitable while the patient is NPO, however if the demand is far exceeding use then a repeat CT scan should be obtained.

   Evidence suggests that patients managed successfully with a non-operative approach are hospitalized on average for four days. However, if no improvement occurs within the first 12–24 h, or clinical deterioration is observed in the form of increasing pain, worsening abdominal distension, development of fever, tachycardia and elevated white cell count, surgical management should be considered. In a select group of patients that completely resolve their bowel obstruction, small bowel studies with water-soluble contrast can be both a useful diagnostic and therapeutic study. This is particularly the case in post-operative SBO or in patients with inflammatory and edematous bowel. Patients who have suffered blunt abdominal trauma and subsequently have an intraluminal hematoma can take several weeks to fully resolve and may benefit from central parenteral nutrition to bridge this period.

O. **(Surgery)** Approximately 1 in 4 patients who present with SBO will require surgical

intervention. Patients with signs and symptoms of complete or high-grade partial obstruction are most likely to require an operation, while patients with peritoneal signs, concerns for ischemia, or hemodynamic instability require urgent intervention. Similarly, patients who fail to resolve with non-operative management will commonly require a trip to the operating room.

The specific approach adopted for management of SBO is dependent upon several factors, namely the patient's habitus, presence of prior abdominal surgery, degree of bowel distension and surgeon preference and experience. Laparoscopic management of SBO, which was first described in 1990, may be appropriate in select cases. Studies have proven benefits to laparoscopic management of SBO, including reduced odds of mortality, major complications, overall complications and length of stay, in addition to reduced total hospital charges. Despite proven benefits, only 15% of SBO cases are managed with a laparoscopic approach in the US. The traditional laparotomy is itself not without risk, with enterotomies occurring in up to 14% of cases.

Once the abdominal cavity has been entered, whether it is with the laparoscopic or open approach, the cause of the SBO should be sought and appropriately addressed. Viability of the small bowel should be assessed at the region of the obstruction and if there is suspicion of non-viability in the form of dusky discoloration, the region should be resected. The entire small bowel needs to be fully inspected to ensure that there is no other compromised region, before the abdomen is closed. If a large portion of the bowel needs to be resected, or the distension is extreme, the operating surgeon has the option to leave the abdomen open with a plan to return in 24 h to reassess, washout and attempt closure. If there is evidence of gross fecal contamination, then leaving the skin open with a wet-to-dry dressing is a suitable option to prevent inevitable wound infection. It may also be of benefit, in the circumstance where the bowel is extremely distended, to decompress the bowel manually by milking the intraluminal contents proximally into the stomach for extraction by an NGT. This maneuver can aid in improving the blood flow to the bowel and can also assist in achieving primary closure.

Several circumstances warrant specific intraoperative strategies. SBO caused by intraluminal bodies such as bezoars or gallstones can be relieved by performing an enterotomy in the region of the obstruction with removal of the obstructing lesion. In the case of gallstone ileus, a cholecystectomy should also be performed and any biliary-enteric fistula resected. If a fistula exists between the common bile duct and the duodenum it may be necessary to perform a choledochojejunostomy. The RUQ may be hostile at the time of surgery and removing the gallbladder poses the risk of inadvertent common bile duct injury, especially if there are dense adhesions. Clinical judgment must be applied in such a situation, as it may be wiser to leave the gallbladder intact. In the case of severely impacted gallstones or other foreign bodies, a small section of small bowel may need to be resected. Another circumstance that warrants an alternative approach is the management of intussusception. In the pediatric population, the lead point of an intussusception is often benign pathology and can be managed with radiological decompression. However, in the adult population, SBO associated with intussusception is associated with malignancy in 50% of the cases and requires surgery to exclude it.

P. **(Palliation)** Patients with intra-abdominal malignancy can prove to be challenging to manage, especially in the context of intra-abdominal carcinomatosis, which can be difficult to ascertain with preoperative imaging. In the situation when the patient has a known recurrence of malignancy, it is vital to understand the patient's goals prior to offering a surgical procedure, as non-operative therapy or surgical palliation may be the most appropriate treatment option. Surgical palliation can take the form of a gastrostomy tube to

decompress the GI system proximally, the formation of a diverting ostomy, or a limited bowel resection.

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72 Small Bowel Conditions: Radiation-Induced Small Bowel Disease (RISBD): Radiation Enteritis

Guy R. Orangio

Mechanism of Radiation Injury

Acute Intestinal Injury in Fig. 72.1

Epithelial Cell Injury

Intestinal homeostasis (IH) is maintained by stem cells that reside in the intestinal crypts. Recent research has discovered adult intestinal stem cell markers, which has led to lineage tracing technologies and innovative *ex vivo* 3D cultures or "enteroid "systems. There are currently two intestinal stem cell (ISC) populations: (1) a rapidly cycling, crypt-based columnar (CBC) stem cell population and (2) a more slowly cycling, quiescent stem cell population that resides in the base of the intestinal crypt. These two stem cell types are controlled by signaling pathways that govern intestinal homeostasis and differentiation, that is critical to the maintenance of the ISC lineage. These intestinal stem cells are also very radiosensitive.

When the target volume dosage of ionizing radiation is reached, it induces double-strand breaks in DNA that triggers activation of the tumor suppressor p53 gene, which along with other cellular factors leads to cell cycle arrest and apoptosis.

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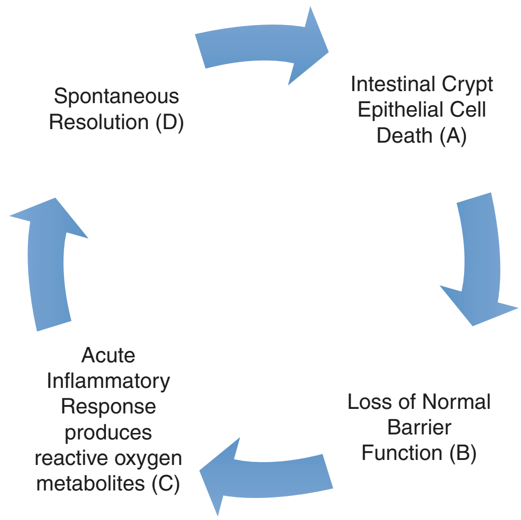

Fig. 72.1 Effect of ionizing radiation leading to acute intestinal injury

A. Intestinal crypt epithelial cells are very sensitive to radiation injury and depends on the severity of epithelial depletion, which is the sole determinant of acute intestinal injury that ultimately leads to radiation enteropathy. With epithelial and stem cell depletion along the intestinal lining, the mucosa cannot regenerate, inducing the acute phase of radiation-induced intestinal disease. As the epithelial cells migrate up the crypt and cannot be replaced, they are eventually shed into the intestinal lumen, causing the crypt to involute.

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B. This leads to injury of the normal barrier function, which leads to exposure of the normally sterile lamina propria to luminal microbes.
C. This triggers an acute inflammatory response associated with immune cellular infiltrates (*i.e.,* T lymphocytes, macrophages and neutrophils). This causes degradation of the extracellular matrix in the lamina propria due to enzymes and mediators released by the immune cells. Activation of leukocytes in the inflamed mucosa produces a large amount of reactive oxygen metabolites that induce significant damage to cellular components including structural and regulatory proteins, carbohydrates, lipids, DNA and RNA.
D. The acute inflammatory process continues, but eventually the crypts start to regenerate. This restores the normal epithelial barrier function, with resolution of the inflammatory response. This repair may be secondary to mesenchymal stem cell mobilized from the bone marrow to the site of radiation injury. The repair is induced by cytokines and potential specific homing induced cytokines released by the inflammatory response.

Chronic Intestinal Injury (Fig. 72.2)

A. The progressive loss of normal barrier function is due to continued invasion of the lamina propria by microbes and immune cells. This can lead to impaired recognition of bacterial translocation, which can further exacerbate the inflammatory process and promote chronic intestinal injury.

   There are two mechanisms that could lead to severe ulceration that leads to a chronic inflammatory course characterized by extensive fibrosis and ischemia.
B. First: bacterial antigens can cause an upregulation of pro-inflammatory factors that leads to prolonged macrophage activation and oxygen radical secretion in order to eradicate bacteria, leading to further tissue destruction.

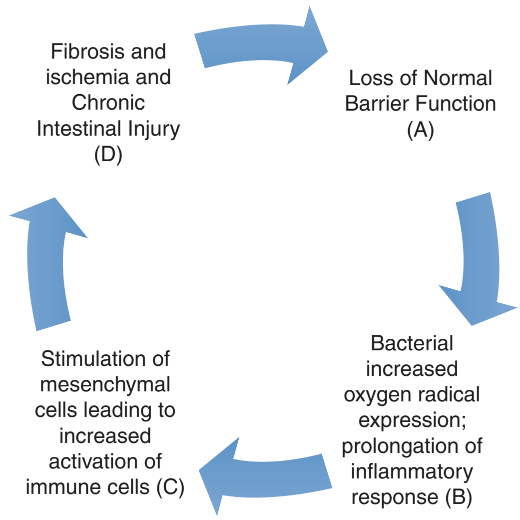

Fig. 72.2 Effect of ionizing radiation leading to chronic intestinal injury

C. Second: prolonged bacterial translocation can stimulate neighboring mesenchymal cells via pattern recognition receptors, leading to increased activation of the immune cells.
D. The inflammatory response becomes exaggerated and the mucosa develops severe ulceration, leading to fibrosis and ischemia. Radiation injury to the vascular supply is a key feature in the pathological process of intestinal radiation injury and a major determinant of acute and chronic effects on the intestine. It is a major factor in initiation, progression, and maintenance of delayed intestinal tissue damage and enhanced fibrosis, which leads to mucosal destruction and stricture formation.

Clinical Risk Factors That Increase the Radiation-Induced Intestinal Toxicity: 74-Table 72.1

There are multiple risk factors that are independent of the radiation technique and are associated with an increased rate of complications following abdominal or pelvic irradiation. The frequency of gastrointestinal radiation complications is directly dependent on the total absorbed dose and the volume of tissue irritated. Patient demographics that

Table 72.1 Clinical risk factors

Demographics	Co-morbid disease	Past medical history	Past surgical history
Female > Male	Collagen vascular diseases	PID	Abdominal
BMI < 17	Inflammatory bowel disease	Ischemic bowel	Pelvic
Age > 60 years	HIV infection	Previous radiation therapy	Post-operative radiation therapy
	Vascular disease	Neoadjuvant therapy	
	Atherosclerosis		
	Diabetes mellitus		
	Cardiovascular disease		
	Cancer staging		

increase the incidence of injury are gender (female > male), history of inflammatory bowel disease (IBD), collagen vascular diseases, human immunodeficiency virus (HIV) infection, history of previous pelvic infection, low body mass index (BMI) <20 kg/m^2, diabetes mellitus, cardiovascular disease, pre-existing vascular compromise of the bowel, previous abdominal and or pelvic surgery, and the addition of neoadjuvant therapy in the immediate perioperative period.

Prevention/Reduction of Radiation-Induced Small Bowel Disease

Radiation Therapy (Table 72.2)

Radiotherapy Techniques

Radiation oncologists have shown a significant improvement in the safety of radiotherapy treatment by optimizing planning and varying delivery techniques by reducing the field size and focus of the radiation beam into the lesion. This minimizes the volume of normal tissue in the radiation field, which reduces radiation-induced small bowel disease. In the early 1990s, radiation oncologists developed a "proposed "radiation treatment plan for a pelvic malignancy by utilizing a dose-volume histogram. This graphic plot measures the cumulative dose-volume frequency distribution within a volume of interest (*i.e.*, target therapy) in the proposed radiation therapy plan for a particular patient. The dose-volume histogram is used to predict the development of radiation toxicity and assist radiation oncologists in identifying low and high-risk patient groups.

Table 72.2 Radiation therapy: prevention of radiation-induced small bowel disease

External beam radiotherapy	**Brachytherapy**
Radiation treatment plan	Interstitial/cavitary
Dose-volume histogram	Limited application
Reduction in radiation field size	**Stereotactic radiation therapy**
Multiple field arrangements	Narrow ionizing radiation
Conformal radiotherapy techniques	Multiple directions
IMRT[a]	Limited application
Image guidance techniques (3D imaging)	**Proton beam radiotherapy**
Patient positioning and devices	Energy stops at target tissue
Prone over supine	Smaller volume of normal tissue effected
Belly boards	Limited application

[a]Intensity-Modulated Radiotherapy

Reduction in field size, multiple field arrangements, conformal radiotherapy techniques, and intensity-modulated radiotherapy (IMRT) can reduce radiation-induced toxicity to the associated normal structures. The utilization of IMRT delivery, in combination with treatment planning to complex targets, minimizes radiation doses to surrounding normal tissue. The advantage of IMRT is the ability to maximize the sparing of normal tissues by changing the shape of the treatment and changing the dose gradients, which can decrease the radiation dose to small bowel by 40%. It can utilize multiple beams with a highly non-uniform dose across fields, which is different than conventional

radiotherapy that uses a small number of beams with uniform intensity. Radiotherapy administration may also be improved by image-guidance techniques. Megavoltage and kilovoltage cone beam computerized tomography provides a 3D image immediately prior to radiotherapy. This improves cancer targeting and reduces the dosage on normal tissue, thereby decreasing levels of toxicity. This technique of 3D conformal technique of delivery can decrease the volume of small bowel that could be inadvertently irradiated by at least 5%.

Brachytherapy

Interstitial/intra-cavitary brachytherapy are advanced techniques of implanting radiation within malignant tissues or within a cavity in the immediate vicinity if a malignancy. These sources can be permanently inserted with emission of a low dose rate over a prolonged period of time or they can be temporary and emit a high dose over a short period of time. This has been utilized in patients with inflammatory bowel disease and low-grade prostate malignancy.

Patient Positioning and Positioning Devices.

This topic has merit and may reduce the incidence of radiation-intestinal disease. There are currently a variety of patient positions and the use of a "belly board", which is designed to reduce the incidence of RID. In patients being treated for pelvic malignancies there is consensus that the prone position decreases the volume of small bowel irradiated than does the supine. Adding the belly board to patients in the prone position has also achieved a slightly less volume of small bowel irradiated.

The important point here is that combining these positioning techniques and IMRT treatment plans may further reduce the small bowel volume irradiated.

Stereotactic Radiation Therapy

This involves a very narrow ionizing radiation beam on a small target from multiple different directions using an immobilization system. It is only rarely utilized in areas that would cause radiation-induced small bowel disease. It has been utilized in patients with prostate cancer, but there are no long-term evaluations of less radiation toxicity effects.

There is literature today that instituting image-guided radiotherapy techniques with high-dose intensity modulation radiation therapy (stereotactic radiation) in prostate cancer patients may reduce both acute and chronic radiation toxicity.

Proton Beam Radiotherapy

The advantage of proton beam energy is that the energy stops in the target tissue, by delivering a higher quantum of energy to kill the cancer cell. There is a smaller volume of normal tissues irradiated at high dose levels, which may mean a reduction in radiation-induced intestinal disease. This is mainly utilized in large-volume malignancies of the liver.

Medical Therapy: Prevention/Reduction of Radiation-Induced Small Bowel Disease (Table 72.3)

There are pharmacologic agents, nutritional supplements, biological response modifiers, and dietary measures that have been investigated to prevent or minimize the severity of radiation-induced bowel injury from ionizing radiation. There are three categories of agents: (1) Radioprotectors are administered prior to radiotherapy for prophylaxis of normal tissue. (2) Mitigators are administered during the course of radiotherapy to minimize the injury. (3) Treatment agents are administered to treat an established injury to the bowel.

Table 72.3 Medical therapy: prevention of RISBD

Agent	Mechanism	Effect
Radioprotectors		
Probiotics	Cytoprotective pathways Counteract: ROS[a] Displace pathogenic bacteria Enhance mucosal integrity	Variable response
Prebiotics	Increases recovery of Lactobacillus species	Decrease in stool consistency
Amifostine	Detoxifies reactive end products of radiation/cytotoxic agents	No benefit
Sucralfate		Worsening of diarrhea
Mitigators/Treatment		
Sulfasalazine		No Benefit
Glutamine	Antioxidant	Worsening of diarrhea
Cholestyramine		Benefit decreasing diarrhea
Pentoxifylline/Tocopherol	Antioxidant	Symptomatic improvement
Budesonide	Inhibits TNF-α/IL-1β Strong anti-inflammatory response Strong cytokine antagonist	
Coniferyl aldehyde	Anti-inflammatory, anti-platelet activity, induces HSF-1 and HSP	
Alpha-lipoic acid	Antioxidant facilitates generation of vitamin E/C	
Mesenchymal stem cells	Stimulate intestinal stem cells to repair	

[a]ROS: Reactive oxygen species; RISBD: Radiation-induced small bowel disease

Radioprotectors

Probiotics

Over the last two decades numerous publications utilizing probiotics for the prevention of radiation-induced bowel disease have appeared. Probiotics have been shown to activate cytoprotective pathways in epithelial cells (in lower doses of radiation on rat small bowel), and counteract reactive oxygen species, displace pathogenic bacteria and enhance mucosal integrity. In human trials, most have been with small patient populations or with ill-defined end points. To date, not one single study is convincing enough to change clinical practice in patients receiving radiation therapy for malignant disease. There is also variability in the patient population as some have rectal cancers that receive neoadjuvant therapy, while many gynecologic malignancies receive preoperative and/or postoperative radiation therapy. There are many different strains of organisms and each with variable response. The consensus is that VSL#3 Lacto Acidophilus maybe the most commonly used and "possible" the most beneficial.

Prebiotics (Inulin and Fructo-oligosaccharide)

These prebiotics have been shown to lead to a statistically significant recovery of Lactobacillus spp. and Bifidobacterium spp. populations (probiotics) after finishing radiotherapy. Patients did have a decreased stool consistency in patients treated with prebiotics during radiation therapy for gynecologic malignancies.

Amifostine (Ethyol)

This drug was developed by the United States Army to protect military personal from radiation. It is a pro-drug, thiophosphate, whose active

metabolite (thiol) is formed by dephosphorylation by alkaline phosphatase within tissues. Thiol detoxifies reactive end products of radiation and cytotoxic agents. When Amifostine is administered daily before radiation therapy it has been shown to reduce the incidence of radiation proctitis and enhance healing of colonic anastomosis. It has not shown any effect on radiation-induced small bowel disease.

Sucralfate (Aluminum Sucrose Octasulfate)

The protective effect of Sucralfate in early double-blind placebo-controlled studies in patients that received pelvic radiotherapy was hopeful. However, later studies either indicated no effect or worsening diarrhea in patients receiving radiotherapy.

Mitigators/Treatment Agents

Sulfasalazine (5-Aminosalicylic Acid)

Sulfasalazine was utilized in a phase 3 randomized trial versus placebo and it failed to show a benefit in reducing enteritis in patients with pelvic malignancies receiving radiation therapy with or without chemotherapy. The study also showed that there was no difference in maximum severity or duration of diarrhea, rectal bleeding, abdominal cramping and constipation when compared to placebo.

Oral Glutamine

Glutamine is the precursor of glutathione (antioxidant), which modulates the inflammatory response, and protects cells from various injuries by producing heat-shock proteins (HSP) and influences apoptosis. In patients receiving glutamine during radiation therapy there was an increase in acute diarrhea versus placebo and also no difference in patients who developed chronic radiation enteritis.

Cholestyramine

It is well known that 95% of bile acids are absorbed in the terminal ileum. It has been shown in patients with acute/chronic radiation enteritis of the terminal ileum that they have decreased bile acid absorption causing increased diarrhea. There have been several studies indicating a benefit in decreasing diarrhea but patient compliance is <40% after one year because the medication has a bad taste and is must be timed if the patient is taking other medications.

Pentoxifylline and Tocopherol

Pentoxifylline is a xanthine derivative and tocopherols are similar compounds to Vitamin E/C activity (antioxidant). This combination of medications has shown symptomatic improvement in patients with radiation enteritis in >70% of patients compared with placebo (33%). It was one study that at least should stimulate further clinical evaluation trials.

Summary

Currently there is no proven prophylactic or therapeutic agent available to patients receiving or have received radiotherapy that mitigates the acute or chronic symptoms or progression of radiation-induced bowel disease nor have they allowed dosage escalation for better control of the underlining cancer.

Experimental Studies in Animals

Budesonide (16,17α-Butylidene Dioxy-11β, 21-Dihydroxy-1, 4-Pregnadiene-3, 20-Dione)

Budesonide is a non-halogenated glucocorticoid that has several means of action, one of which inhibits formation of leukotrienes and prostaglandins, both of which are known mediators of inflammation. Most cells have recep-

tors for glucocorticoids so budesonide is effective in patients with inflammatory bowel disease. Budesonide also inhibits TNF-α and IL-1β from monocytes and has a 20-fold higher anti-inflammatory response than dexamethasone, thus a very strong cytokine antagonist. In this study, the group of rats given pre-radiation doses of budesonide then radiotherapy had less weight loss, less diarrhea and normal morphology of the jejunum, ileum and colon. This is very promising and should warrant clinical trials.

Coniferyl Aldehyde (CA)

Coniferyl aldehyde is a phenolic compound found in extract from plants (Cinnamomum cassia, Senra incana, Ficus foveolata and Eucommia ulmoides) found in Asian traditional medicines that has anti-inflammatory activity and anti-platelet aggregation activity and is a potent inducer of Heat Shock Factor-1 (HSF1), which up regulates Heat Shock Proteins (HSP). These heat factor proteins protect cells from oxidative stress, heat and radiation. In this study the radio-protective effects of CA were investigated and found that CA significantly mitigated radiation-induced enteropathy by increasing endothelial cell survival and eventually allowing the intestine to recover in rats.

Alpha-Lipoic Acid (ALA)

Alpha-lipoic acid is an antioxidant compound that is used to scavenge reactive oxygen free radicals and facilitates generation of vitamin C and E to elevate tissue levels of Glutathione (GSH)-elevating agents (antioxidants). In this study the ALA treated mice mitigated the symptoms of radiation-induced small intestinal injury, protected the intestinal mucosa from injury, decreased apoptosis in the small intestine, and restored GSH levels and reduced oxidative stress following radiation.

Mesenchymal Stems Cells

The loss of intestinal stem cells (ISCs) residing in the base of the intestinal crypts has a role in the radiation-induced small bowel injury. The ISCs are responsible for maintaining intestinal epithelial homeostasis and regeneration following injury. Mesenchymal stem cells (MSCs) have been shown to improve intestinal epithelial repair in mouse models of radiation injury. There are two populations of stem cells in the crypts of base columnar cells called Lgr5$^+$ (grow to form "enteroids") and Bmi 1$^+$ (quiescent, slow cycling stem cells). Systemic administration of MSCs improves intestinal epithelial repair in animal models of radiation injury. MSC transplantation increased higher number of enteroids, reduces the number of apoptotic cells within radiation injured small intestine, and supports the growth of endogenous Lgr5$^+$ ISCs which promotes repair of the small intestine following exposure to radiation. The molecular action of mediation is related to the Wnt/β-catenin signaling pathway.

Surgical Techniques for Prevention of Radiation-Induced Small Bowl Disease (Table 72.4)

Although postoperative radiation therapy for colorectal cancer is a rare occurrence today, in patients with genitourinary pelvic malignancies it is more common. Over the years there are some techniques for small bowel exclusion from the pelvis

Table 72.4 Surgical prophylactic techniques

Operative exclusion techniques	Effect: reduced small bowel volume in pelvis
Pelvic Reconstruction	60%
Omentoplasty	60%
Transposition of Bowel	60%
Implants	
Biodegradable Mesh Slings	50%
Space Occupying Silicone Implants	Pelvic Mass Effect

when radiation therapy is indicated postoperatively. The results of these methods of "exclusion" techniques have not been consistently reproduced in clinical practice and some require a second operation to remove the implant. Implants are associated with mass effect in the pelvis causing hydronephrosis, obstruction and fistula (erosion) formation. Constructing a pelvic sling with biodegradable mesh (popular in the 1980s) was performed with the idea that it would eventually be absorbed and "temporarily" excludes the small bowel from the pelvis--thus protecting it from radiation injury. Recently a surgical technique mobilizing the bladder and suturing it over the pelvic inlet as a sling to exclude the small bowel from the pelvis for postoperative radiation has been somewhat successful. Overall, these techniques have not been incorporated in to the mainstream of surgical prophylaxis to prevent radiation-induced small bowel disease.

Refer to Algorithm in Fig. 72.3 Treatment of Radiation-Induced Small Bowel Disease

Acute Injury

Patients with acute enteritis develop a variety of symptoms, so the management is divided into supportive and dietary interventions as well as medical therapies. More rarely surgical therapies are warranted. The most common (up to 50–70%) are diarrhea, colicky abdominal pain, bloating, nausea, vomiting, and loss of appetite. When these symptoms (severity varies from 15 to 30%) arise during radiation therapy or neoadjuvant therapy, these therapies are either modified or halted, which can hamper the radiation therapy goals. However, these symptoms resolve in the vast majority of patients within 3 months.

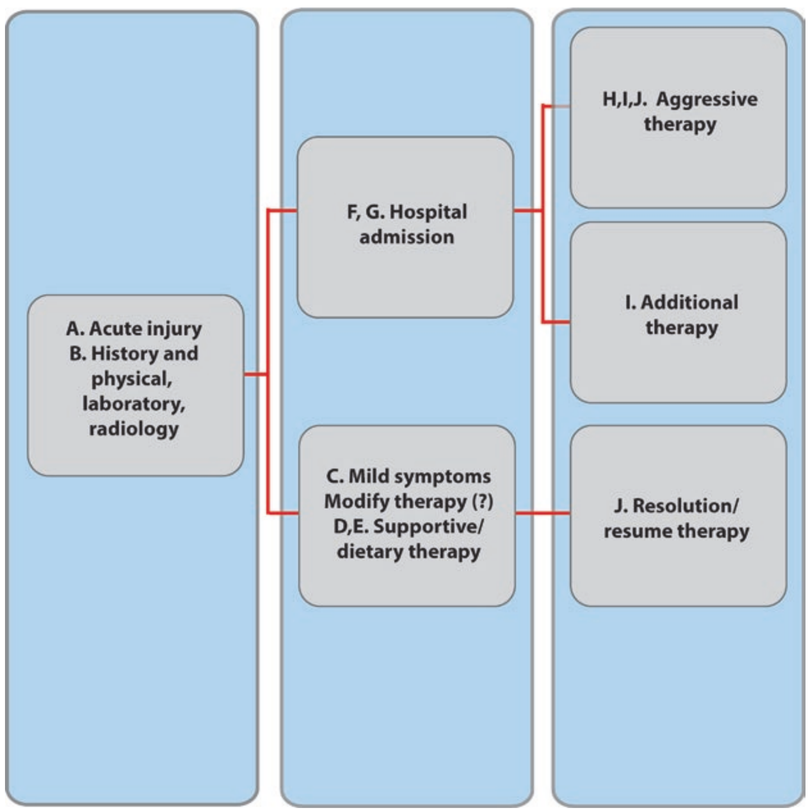

Fig. 72.3 Algorithm for management of acute radiation small bowel injury. Usually managed by medical oncologist/ hospitalists

A. All patients with symptoms of acute enteritis require a history and physical evaluation, laboratory evaluation (CBC, chemistry panel, including pre-albumin, C-reactive protein, stool cultures) and radiographic evaluation. These patients all require a diagnostic radiographic analysis depending on the severity of the symptoms or if they fail supportive therapy. This may include abdominal radiographs (plain films) and or CT scan/MRI of abdomen pelvis, depending on the clinical presentation or progression of symptoms.
B. Patients with mild symptoms can be managed with supportive therapy and dietary modifications without modification of the radiotherapy.
C. Supportive Therapy Medications (Based on clinical experience)
   (a) Antidiarrheal: Loperamide, Cholestyramine
   (b) Anticholinergic antispasmodic agents: alleviate bowel cramping
   (c) Analgesics for pain: oral narcotic
   (d) Anti-emetics: nausea
D. Dietary Modification (based on clinical experience)
   (a) Damage of the intestinal villi leads to some degree of malabsorption
   (b) Important to ensure sufficient caloric, protein and fluid intake
   (c) No particular diet; however, nutritional supplements such as high-protein, high-caloric drinks with low osmolality so not to increase the patient's symptoms.
E. Resolution or improvement of symptoms then resume therapeutic goals if the therapy was modified
F. Severe symptoms may need inpatient hospital management in order to evaluate and treat electrolyte imbalance, malnutrition and possible sepsis.
G. Aggressive rehydration, electrolyte replacement
H. Additional therapy if symptoms progress while in the hospital: may require intravenous antibiotics for signs and symptoms of sepsis and if required treatment of neutropenia, addition of somatostatin analogue octreotide and treatment of malnutrition; may need parental nutrition.
I. If symptoms resolve, therapy can resume or may be modified if the injury if was life-threatening. Some patients may not permit resuming the radiation therapy or neoadjuvant therapy.
J. Resolution of symptoms and resumption of the therapy.

Surgical Therapy of Chronic Radiation-Induced Small Bowel Disease

Surgical Procedures: Resection vs. Intestinal By-Pass

The incidence of chronic radiation-induced small bowel disease is between 5 and 15% of patients receiving pelvic radiotherapy/neoadjuvant therapy, with onset of 3 months to 15 years post completion of therapy. Over 30% of patients with chronic radiation-induced small bowel disease will require surgical intervention (Table 72.5). The onset of symptoms requiring surgical therapy

Table 72.5 Indications for surgical therapy of radiation-induced small bowel disease

Symptom	Percentage of patients
Intestinal obstruction	**Total 70–80**
Ileum/Ileocecal	
Jejunum	
Combined: SB[a] and Colon or Rectum	
Fistula	**Total 20–25**
Ileocutaneous	
Ileovaginal	
Ileovesical	
Ileorectal	
Ileoperineal	
Combined SB[a] and Colon or Rectum	
Malabsorption	**Total 2–5**
Perforation (Emergency)	**Total 3–5**
Gastrointestinal Hemorrhage	**Total 1–2**

[a]Small bowel

ranges from 1 to 157 months, with a median of 5 months in one study, and in another study it ranged from 1 to 397 months (median, 20 months post-therapy). The surgical philosophy for radiation-induced small bowel disease has been controversial for over 30 years, with intestinal bypass, lysis of adhesions or diverting ostomy vs resectional therapy being the most commonly prescribed operations. I think that it is clear today that resectional therapy with anastomosis or ostomy is the preferred approach. When utilizing intestinal bypass or lysis of adhesions or proximal diversion without resection the morbidity of leaving the diseased bowel *in situ* can cause hemorrhage, perforation, and fistula formation, development of blind loop syndrome, recurrent/persistent obstruction, and increased reoperation rate. In several studies resection of the diseased bowel is the best approach. The most common site of resection is the ileocecal region with primary anastomosis. With resection and anastomosis there is a significant decrease in reoperation rate. I agree that when there is terminal ileal disease and ileocecal resection is indicated, resection with ileo-transverse colon anastomosis is the preferred technique. The complications of anastomotic leak, intra-abdominal abscess, intestinal fistula or postoperative peritonitis, wound dehiscence and intra-abdominal hemorrhage are ~10.8%, with an overall surgical complication rate of 12.7%, a reoperation rate of 8.2% (incomplete resection with recurrent obstruction was 1.9%), and associated mortality of 1.9% in one study. In patients with ileal/ileocecal resection and construction of end ileostomy, there was a similar incidence of postoperative complication as patients with anastomosis (10–12%). Only 9.5% of patients had two-stage operations. Postoperative short bowel syndrome (<180–200 cm of small bowel) was observed in 14.5% of patients. The median follow-up of patients was 20.3 (3–128) months, and at the end of follow-up 12.1% of patients with intestinal failure were permanently dependent on parenteral nutrition. Interesting, in earlier studies there was a 32% incidence of parenteral nutrition in resected patients and a 38% incidence in patients treated with non-resectional surgical therapy. Repeat surgery for patients with chronic radiation-induced small bowel disease has a median time of 16 months after the first surgery, with an overall cumulative reoperation rate of 37% (1 year), 54% (3 years) and 59% (5 years), and an overall cumulative mortality of 5%. The only protective factor for reoperation was ileocecal resection at the first operation. In patients that did not have an ileocecal resection at first procedure, there was a 59% reoperation rate at one year. In highly selective patients with a high risk of short bowel syndrome, strictureplasty may be utilized (Table 72.6).

Preoperative Surgical Risk Factors

Table 72.7 lists risk factors for higher postoperative complication rates in patients with chronic RISBD. Sixty percent of patients with chronic RISBD have malnutrition. All of these patients with obstruction or enterocutaneous fistula should

Table 72.6 Surgical procedures performed for small bowel obstruction

Surgical procedure	Percent
Ileocecal Resection/anastomosis	47.5
Ileal Resection/anastomosis	38.0
Ileal & Ileocecal resection/anastomosis	2.5
Resection & Permanent Ileostomy	12
Ileal & Ileocolic resection/with anastomosis and/or colonic stoma	10.1
Strictureplasty	Highly Selective

Table 72.7 Risk factors for post-operative complications

American Association of Anesthesiologists (ASA) III-IV
Preoperative Anemia <11. 0 g/L
Preoperative Platelet Count <100,000
Intra-operative Transfusion/Blood loss >400 ml
Operative Time of >3 h
Concomitant* Radiation Uropathy with associated increased creatinine
Concomitant Radiation Proctitis
Less Experienced Surgeon
Previous Surgery for Chronic Radiation-Induced Small Bowel Disease
Malnutrition

Over 66% of patients with pelvic radiotherapy have 2 or more concomitant injuries

be optimized pre operatively with either enteral nutrition (EN) or parenteral nutrition (PN). Some authors utilize a Cantor tube (long intestinal tube) to decompress patients with obstruction until their nutritional status is improved before performing a surgical procedure.

Refer to Algorithm in Fig. 72.4 Algorithm of Surgical Therapy Chronic Radiation-Induced Small Bowel Disease (Chronic RISBD): Emergency Procedures

Small Bowel Hemorrhage

A. Patients with chronic radiation-induced small bowel disease who present with significant small bowel hemorrhage or perforation represent true emergency patients. Usually patients presenting with gastrointestinal hemorrhage require a multidisciplinary team approach: including surgeon, gastroenterologist, interventional radiologist (IR), and critical care specialists.
B. Gastroenterologists that are involved must be able to perform Double-Balloon Enteroscopy (DBE) and Video Capsule Endoscopy (VCE). Additionally, intraoperative enteroscopy can be utilized to assist in localizing the bleeding site. Utilization of VCE can cause obstruction if there is an unknown stricture in the small bowel, therefore, if possible, a CT enteroclysis (CTE) can be helpful to rule out a non-symptomatic stricture.
C. The patient will require resuscitation with intravenous fluids, and or transfusion, usually in an Intensive Care Unit.
D. If the patient stabilizes and the bleeding stops spontaneously, the patient can have an evaluation including colonoscopy, upper endoscopy), CTE, DBE and or VCE. I believe that this work-up should be performed to isolate the site of the abnormal bowel in case of re-bleeding.
E. If the patient does not stop bleeding, then the diagnostic work-up should include endoscopy (colonoscopy, upper endoscopy) and IR assistance if the bleeding is rapid enough and possible embolization therapy is needed. Utilizing a gastroenterologist with DBE ability can be very helpful and they can perform a diagnostic (localize site of hemorrhage) and in some cases therapeutic procedure. Then urgent laparotomy with resection and anastomosis or ostomy can be performed.
F. If patient continues to bleed, emergency laparotomy with intraoperative enteroscopy should be performed to isolate the site. Resection of the involved segment of small bowel with subsequent anastomosis or ostomy can then be performed.

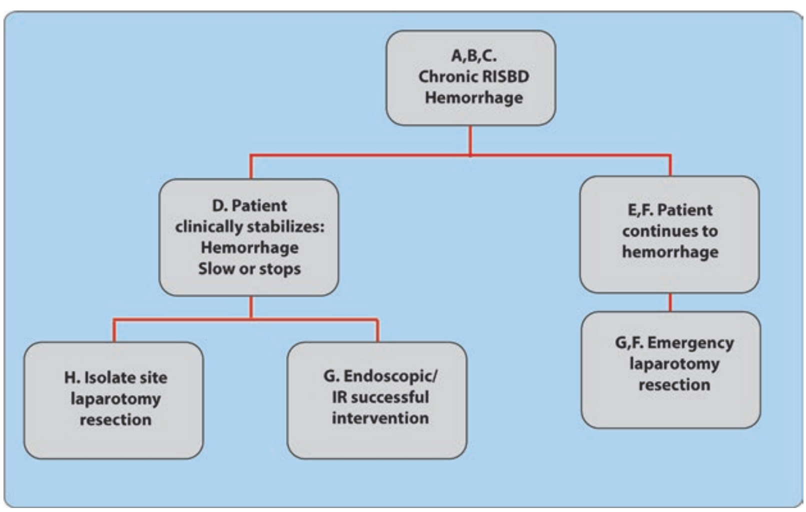

Fig. 72.4 Algorithm for surgical therapy chronic RISBD: emergency GI hemorrhage

G. Urgent” laparotomy with resection of the involved small bowel and anastomosis or end ileostomy is occasionally required for those that do not respond.
H. If the bleeding “slows’” and patient stabilizes isolate the site of bleeding and perform laparotomy and resection of segment of small bowel with anastomosis.

Perforation

If there is a perforation of small bowel, fluid resuscitation, broad-spectrum antibiotics and emergency laparotomy with resection of the perforated segment and either anastomosis or an ostomy is required. The decision of whether to perform an anastomosis or and ostomy is up to the operating surgeon and is often based on his/her experience and the clinical findings at the time of the laparotomy. There is no need for and an algorithm with this patient.

Refer to Algorithm in Fig. 72.5 Surgical Therapy for Chronic Radiation-Induced Small Bowel Disease (Chronic RISBD): Small Bowel Obstruction

A. Small bowel obstruction is the most common presentation of patients with chronic RISBD. These patients have had symptoms for quite some time and over 60% will present with some level of malnutrition. If the patients can be stabilized-- meaning control of nausea/vomiting with a nasogastric tube if needed--then the goal should be to begin with evaluation of their nutritional status and then correction with either parenteral nutrition or enteral nutrition (if possible). There is some literature utilizing a long gastrointestinal tube (Cantor), and while I haven’t used this tube in decades, it may have some value. If it is possible to improve the patient’s nutritional status, then proceed with laparotomy and resection of small bowel segment and primary anastomosis.

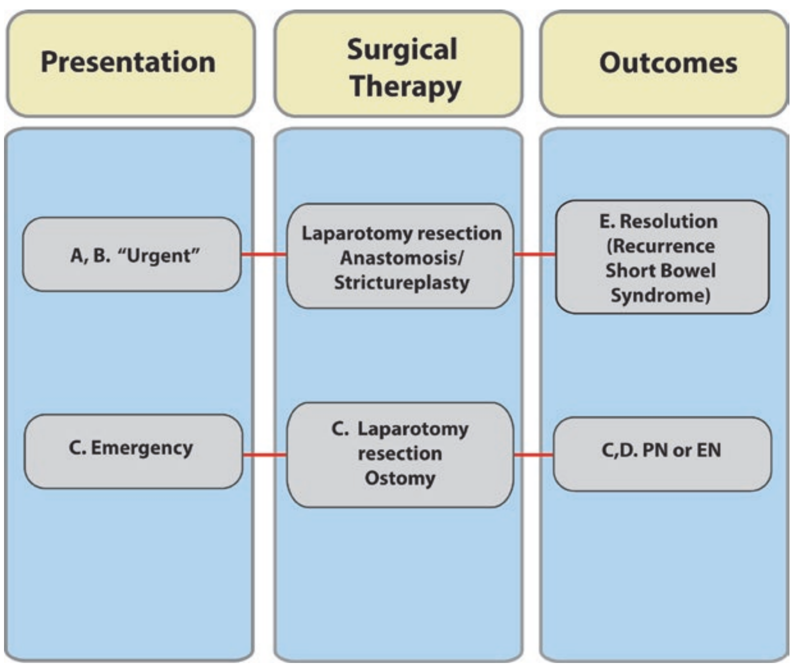

Fig. 72.5 Algorithm for surgical therapy for chronic RISBD: obstruction/fistula. *EN* enteral nutrition, *PN* parenteral nutrition

B. Patients that are stabilized and able to improve their malnutrition can then have diagnostic evaluation including colonoscopy, CT /MRI enterography to define the site (s) of obstruction(s) to allow for surgical plan of resection, or in rare instances, strictureplasty.
C. However, if the patient is clinically developing progression of the obstruction and impending perforation, an emergency laparotomy with resection of the segment and primary anastomosis or ostomy may need to be performed. The decision is up to the operating surgeon to perform an anastomosis, although there is a higher incidence of anastomotic leakage in radiation bowel and associated malnutrition, it may be safer to construct an ostomy.
D. The patients operated on emergently will require PN or EN for at least 3–6 months before reoperation to restore gastrointestinal continuity.
E. The long-term outcomes of patients with chronic RISBD fall under three categories:
   (a) Resolution with the primary resection and anastomosis with no postoperative complications: follow for any signs of recurrence of symptoms and for their increased risk of a primary cancer.
   (b) Recurrence/risk of reoperation rates for chronic RISBD at 1-year and 3-years is 37 and 57%, respectively. The risk factors for this are undergoing an emergency procedure, developing an anastomotic leakage or undergoing non-resection surgery (i.e., bypass surgery and lysis of adhesions). The most significant protective factor against reoperation is ileocecal resection.
   (c) Intestinal failure (short bowel syndrome) is defined as "a reduction in the functioning gut mass characterized by the inability to maintain protein-energy, fluid, electrolyte and /or micronutrient balance." Short bowel syndrome is one of the pathophysiologic conditions found in patients with chronic RISBD from direct effect of the injury and surgical resections. Many of these patients are dependent on PN and/or EN, and must be managed by a multidisciplinary team. Overall, only 4% of patients with intestinal failure fall under this category. Unfortunately, the overall survival rate of these patients who are PN dependent for 1-year, 5-year and 10-year is 78%, 57.8% and 48.2% respectively.

Refer to Algorithm in Fig. 72.6 Surgical Therapy for Chronic Radiation-Induced Small Bowel Disease: Enterocutaneous Fistula (C)

Patients with chronic RISBD can develop an EC fistula in ~25%. It may either be spontaneous or in a small percentage of patients from a postoperative anastomotic leak. A multidisciplinary team including surgeon, nutritional therapist, wound and ostomy nurse are useful in the management of these cases. The principles of managing an EC fistula are control the effluent (high or low output fistula), control sepsis, stabilize electrolytes, begin nutritional support (PN or EN), and eventually surgical take down of the EC fistula. The surgeon must be very "patient" and control the desire to re-operate on these patients to soon. These patients need at least 3–6 months of nutritional support before they are brought back to the operating room. In patients with an EC fistula secondary to chronic RISBD, they almost always do not heal spontaneously, and surgical therapy is inevitable. The surgeon must realize that even under optimal conditions there is at least a 20% failure rate at the first operation.

A. When the patient is clinically optimized, nutritional status is normal and is well informed of the risks of the procedure.
B. Laparotomy with resection of the small bowel and anastomosis is performed.

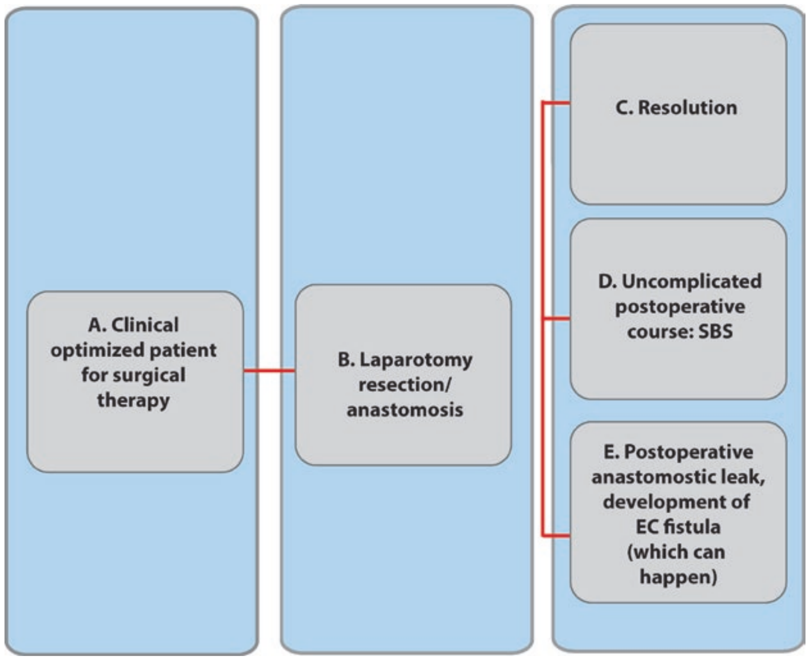

Fig. 72.6 Algorithm for surgical therapy for chronic radiation-induced small bowel disease: enterocutaneous fistula

C. Resolution; no postoperative complications. Some patients may need some supplemental PN or EN while recovering. Many of these patients can be put on a clinical pathway postoperatively with excellent success.
D. Resolution; uncomplicated postoperative course but they are left with short bowel syndrome and will require home PN. Many centers also have multidisciplinary teams or facilities that can give long-term care.
E. Postoperative anastomotic leak with development of an EC fistula, which will mean starting over from (**A**) again. As long as the patient was well informed about this possibility they will typically stay with the original surgeon.

Summary Points

- Radiation therapy for a pelvic malignancy is becoming the standard of care and leads to radiation induced small bowel injury.
- People will continue to develop acute and chronic RISBD.
- The management of patients with chronic RISBD with associated GI hemorrhage, bowel perforation, obstruction, or development of enterocutaneous fistula should be managed at a center with a multidisciplinary team with an experienced surgeon.
- For the surgeon, the procedure of choice should be resection of the diseased segment.
- Chronic RISBD is a life-long disease in many patients, which will negatively affect their quality of life, especially with the long-term risks of reoperation and even intestinal failure.

Suggested Reading

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Enterocutaneous and Enteroatmospheric Fistula

73

Jason R. Bingham and Eric K. Johnson

Refer to Algorithm in Fig. 73.1

A. Enterocutaneous fistula (ECF) is a devastating complication with high morbidity that causes much distress and frustration for the patient as well the entire health care team. Broadly speaking, a fistula is an abnormal connection between two epithelialized structures and are commonly defined based on upon their anatomic origin. The severity of ECF can vary widely from a relatively easily controlled low output colocutaneous fistula to a high output enteroatmospheric fistula (EAF) requiring prolonged nutritional support, extensive wound management, and complex reconstructive surgery (Fig. 73.2a, b). EAF is a special subset of ECF that occurs when there is direct communication between the gastrointestinal tract and the atmosphere. ECF and EAF have unique differences in terms of their nutritional, wound, and surgical needs. However, there is clear overlap in the way these entities are managed and these patients are typically very complex requiring a well-organized multidisciplinary approach in their management.

B. ECF most commonly occurs as a complication following an abdominal procedure, but may also be secondary to malignancy, fistulizing Crohn's disease, abdominal sepsis, mesh erosions, and trauma. EAF is considered a devastating complication following damage control laparotomy for trauma, or may also occur after surgical complications in the setting of significant wound and fascial dehiscence. The etiology is complex and generally results from any combination of persistent intra-abdominal infection, bowel adhesions, repeated operations with bowel manipulation, and bowel damage during dressing changes or secondary to improper use of negative pressure wound devices. ECF and EAF rarely pose a diagnostic dilemma as the presence of enteric contents draining from an abdominal wound generally induces an intuitively visceral response from both the patient and the surgeon (Fig. 73.3).

C. ECF and EAF are further classified by the amount of efflux over a 24-h period—with <200 ml per day being considered as "low output," 200–500 ml per day as "intermediate output," and >500 ml per day as "high

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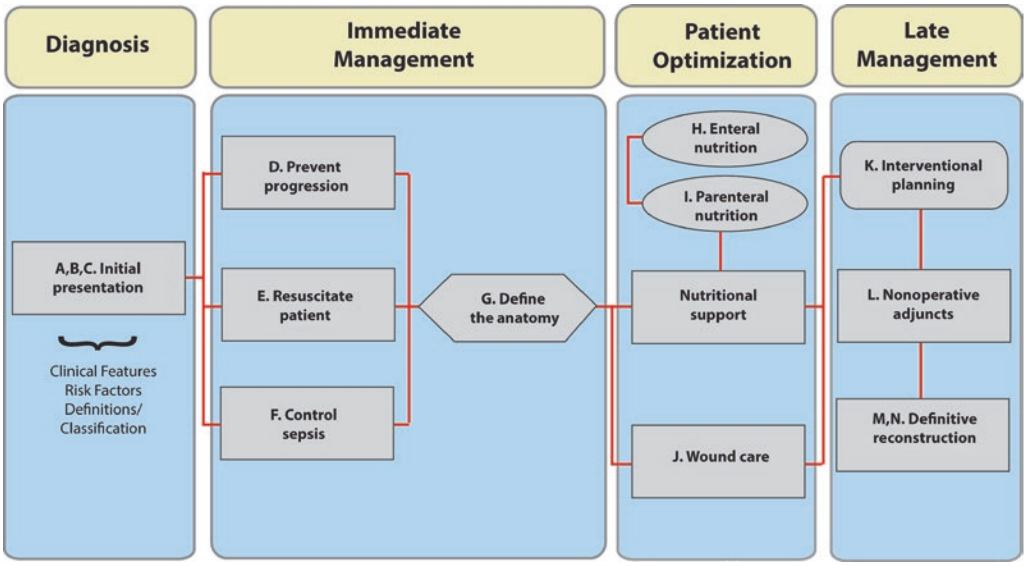

Fig. 73.1 Algorithm for management of enterocutaneous and enteroatmospheric fistula

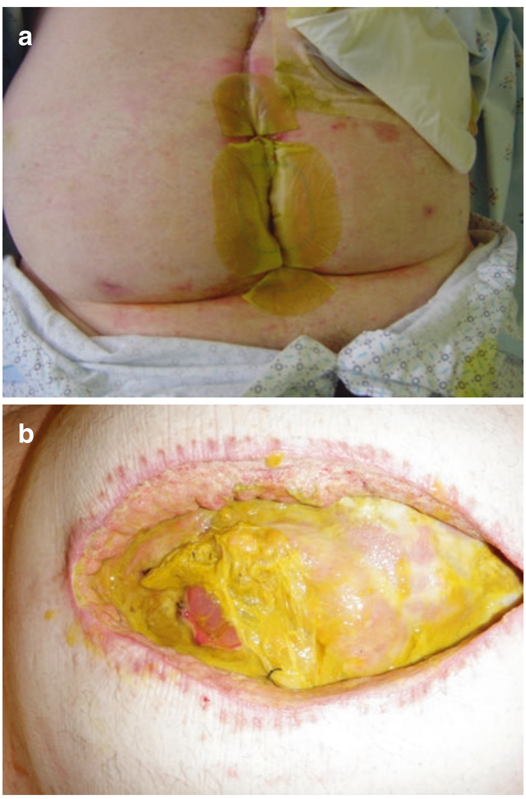

Fig. 73.2 (**a**, **b**) These images show the appearance of a relatively small and controlled fistula, vs. a large enteroatmospheric fistula that will require extensive means to achieve control

Fig. 73.3 This image depicts a newly diagnosed fistula as enteric contents begin to emerge from the wound. Often there is initial diagnostic uncertainty or denial that there is in fact a fistula present. A CT performed with enteral contrast or administration of oral activated charcoal or a colored dye may assist in making the diagnosis

output." While these designations are somewhat arbitrary, accurate quantification of a fistula's efflux is crucial for predicting the probability of spontaneous closure and for planning of later surgical intervention. While a significant number of ECF will close with non-operative management, EAF will almost universally require some form of surgical intervention. In general, high output fistulas carry an increased morbidity and mortality, as well as a lower rate of spontaneous closure. The familiar "FRIENDS" mnemonic often recited by interns and medical students on surgical rounds remains useful for identifying ECFs less likely to close spontaneously. The presence of a Foreign body, prior Radiation, ongoing Inflammation or Infection, an Epithelialized tract, a Neoplasm, Distal obstruction, and use of Steroids or presence of Sepsis all dramatically decrease the likelihood of spontaneous closure.

D. Clearly, the best approach to ECF and EAF is to avoid their occurrence in the first place. Adhering to the tenets of meticulous bowel handling, avoidance of enterotomy, and careful abdominal wall closure during laparotomy is paramount to prevention of this devastating complication. ECF and EAF following damage control laparotomy is unfortunately not an uncommon occurrence. In these circumstances, all attempts at early abdominal wall closure should be made as higher rates of complications, to include fistula formation, have been demonstrated if the abdomen is left open for greater than 8 days. In reality, abdominal wall closure is not simply a matter of choice, and factors such as visceral edema and intra-abdominal hypertension drive the timing of definitive closure (Fig. 73.4). Again, the surgeon should maintain near paranoid levels of scrutiny with regards to the avoidance fistula formation in the management of open abdomen. The edematous bowel is especially susceptible to damage during the frequent trips to the operating room required of these patients. The improper application of negative pressure devices used in this setting can often be the inciting insult leading to fistula formation. In the absence of a skilled wound care specialist, a senior member of the surgical team should be present at all dressing changes in these tenuous patients to avoid disaster.

Fig. 73.4 This patient has significant bowel edema which will preclude definitive abdominal closure. It is best to prevent a situation such as this, as a prolonged period with an open abdomen lends itself to the potential of fistula formation

E. Once an ECF/EAF is present, immediate attention should be placed on patient stabilization by controlling sepsis and fluid/electrolyte resuscitation. Attention is then turned defining fistula anatomy, wound/effluent control and skin protection, and nutritional support. The management team must then determine the potential for spontaneous closure with continued aggressive non-operative management versus the need for eventual definitive surgical intervention. The decision for surgical intervention should be approached cautiously; with a thorough understanding of the complex abdominal wall reconstruction that is invariably required

and focus should be placed on mitigating the risks associated with the closure itself.

F. The initial priority is resuscitation and control of sepsis. As with any septic patient, aggressive fluid resuscitation, invasive hemodynamic monitoring, and broad spectrum antibiotics may be required. The basic principles of fluid resuscitation are the same in patients with ECF and EAF as they are with any post-surgical patient. High output fistulas are especially prone to severe electrolyte derangements, and close monitoring and replacement is necessary. The most appropriate replacement fluid depends on the site of origin for the fistula. In most cases, normal saline with 10 mEq/l KCl will suffice. However, very proximal small bowel fistulas may require bicarbonate replacement as well.

G. A computed tomography scan of the abdomen and pelvis should be performed early in the process, both to assist in defining fistula anatomy as well as to evaluate for intra-abdominal sources of ongoing sepsis. Any intra-abdominal source should be drained, preferably percutaneously with the assistance of interventional radiology. However, this maneuver may not always be possible and any source of sepsis that is not amenable to percutaneous drainage may require early reoperation for the sole purpose of sepsis control. Rarely, the ECF may be definitively addressed during this initial exploration. Typically this involves resection of the leaking segment of bowel with anastomosis and possible diversion, depending on the individual situation and surgical judgment. However, unless an isolated modifiable factor is found that led to the leak and fistula formation, it is unreasonable to expect that the new anastomosis will heal in a hostile environment. If resection and anastomosis is undertaken, proximal diversion should be considered to prevent or minimize the clinical impact of re-fistulization. However, often times this will not be possible secondary to mesenteric foreshortening and bowel immobility. In these instances, one may be left with wide drainage using closed suction or sump-type drains as the only option.

H. Perhaps the most important yet challenging component of ECF and EAF management is the subject of nutrition. Significant nutritional disturbances are present in up to 90% of enteric fistula patients. This no doubt contributes to the morbidity and mortality of the disease and optimization of a patient's nutritional status is essential to promoting spontaneous healing as well as in preparation for a reconstructive efforts should they be necessary. The development of parenteral nutrition during the 1960s was a profound leap forward in the treatment of ECF and EAF. Notably, fistula closure has been shown to be twice as likely in patients receiving nutritional supplementation. Traditional dogma teaches that bowel rest plus total parenteral nutrition will result in improved rates of spontaneous closure. While there is evidence that this therapy does result in reduced fistula output, there is no current evidence that this translates to improved rates of fistula closure and the concern that enteral nutrition will contribute to delayed fistula closure is likely unfounded. In fact, risk of fistula formation is decreased in trauma patients managed with an open abdomen if enteral nutrition is given. Hence, the surgical adage "if the gut works, use it" appears to also be applicable to the patient with ECF and EAF. This is not surprising given the well-known benefits of enteral feeding with regard to maintaining gastrointestinal mucosal immunity/integrity. Currently, enteral nutrition is preferred over parenteral unless there is a clear contraindication. Parenteral nutrition should be reserved for either those patients who cannot tolerate enteral feeds due to ileus or obstruction or for supplementation in patients in whom full enteral nutrition is insufficient secondary to short gut or uncontrollable fistula efflux. In patients with a proximal enteric fistula, a process of re-feeding enteroclysis can be utilized in which the fistula efflux is re-fed via a feeding tube placed distally. This process has been shown to be effective in avoiding parenteral nutrition in select patients. Additionally, there are

many elemental formulations available that may minimize or even decrease fistula output. As such, an experienced nutritionist is an essential member of any multi-disciplinary team caring for ECF and EAF patients. Fortunately, by utilizing the therapy principles outlined above, adequate nutritional support can be obtained in most individuals without being reliant on parenteral infusions.

I. While enteral nutrition is clearly desirable, there will be times when this will result in an unmanageable wound because the fistula output is simply too high to reasonably control. In these cases, total parenteral nutrition is likely the best option until output becomes more manageable. Somatostatin and associated analogues have been investigated in conjunction with conservative management of ECF. When given in addition to parenteral nutrition, there appears to be a synergistic effect on the reduction of gastrointestinal effluents. It is important to note, however, that while this may be useful for controlling sepsis and wound management, there is no convincing data to show that parenteral nutrition with or without somatostatin increases the rate of fistula closure. It is also important to realize that the majority of these patients are in a profoundly catabolic state. As such, they often require supplementation far in excess of the standard postoperative patient. In fact, the patient may require up to 30 kcal/kg and 2.5 g/kg of protein with supplementation of zinc, copper, folic acid, vitamin B12, trace elements, and 5–10 times the standard recommendation of vitamin C.

J. Effective wound management is often a demanding and resource intensive process in patients with ECF and EAF. As one would expect, enteric contents coming in direct contact with the skin results in significant excoriation, maceration, and severe pain and misery for the patient (Fig. 73.5). Adequate control of fistula effluent with protection of the surrounding skin is of utmost importance. Negative pressure wound therapy (NPWT) undoubtedly represents a significant advance in the management of complex wounds. However, high output ECF and EAF can overwhelm these devices, resulting in leakage onto the surrounding skin and requiring daily, if not hourly, dressing changes. This can rapidly engulf hospital resources and become nothing less than a living nightmare for the patient as well as the care team. If the patient is being cared for at a hospital that does not have advanced wound care and enterostomal therapist, they should be transferred to a higher level of care. While there are now devices available specifically designed for ECF and EAF isolation, experience with these new devices is limited and there is currently only sparse data demonstrating their efficacy. This has resulted in the development several creative methods and systems in an effort to address the complex wound care needs of these patients (Fig. 73.6). Each of these methods is centered on a few simple principles: (1) "dam off" the ECF or EAF

Fig. 73.5 This image shows how the skin around a fistula may become quite irritated and inflamed if enteric contents are not well controlled. Contact between the skin and these contents must be avoided

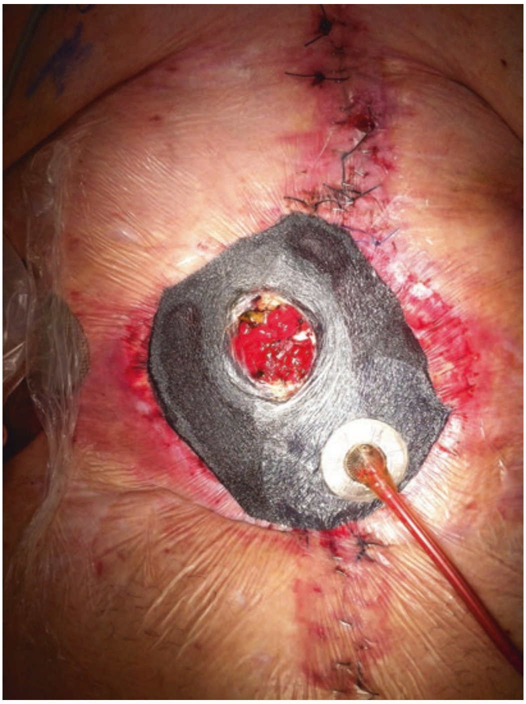

Fig. 73.6 Pictured is a modified negative pressure dressing that is designed to wall off an enteroatmospheric fistula, such that the benefits of negative pressure may be realized while controlling fistula effluent. An ostomy appliance may be placed over the fistula (on top of the dressing) to control and capture output

from the surrounding bowel and granulation tissue, (2) provide NPWT to the surrounding tissues to aid in wound contraction and healing, (3) protect and preserve the surrounding skin, and (4) prevent trauma to the underlying viscera. As the particular wound care needs can be extremely variable from patient to patient, it requires considerable resources to design a custom device for a specific patient and ensure its effective use. This issue underscores the fact that a seasoned enterostomal therapist and wound care team is truly invaluable. However, sometimes despite the most extraordinary of efforts, effluent control can simply not be controlled with NPWT based devices. When this occurs, the only remaining option is large stoma-like appliance known as a wound manager. These devices are fitted and applied in a similar manner as a standard ostomy appliance. Peri-wound skin care is exceedingly important with these devices, as a watertight seal is essential for adequate effluent control. Ideally, device changes should be done as infrequently as possible in order to limit damage to the underlying skin, preferably every 4–5 days.

K. A significant subset of ECF, and nearly all EAF, will eventually require surgical intervention. Once the patient has been appropriately resuscitated, nutrition has been optimized, and an effective wound care strategy has been enacted, the next major decision point is determining the appropriate timing of surgical reconstruction. This is an area of active debate as there is currently no level I data supporting any particular timing strategy. Expert consensus recommends a minimum delay of 3 months from fistula formation prior to any attempt at operative repair. The overall goal is to allow sufficient time for the inflammatory process to resolve and for abdominal adhesions to soften. Doing so will reduce the risk of iatrogenic bowel injury during reconstruction. Importantly, patients who had previously been managed with split thickness skin grafting over exposed bowel will require a longer interval prior to proceeding with operative reconstruction. In these patients it typically takes upwards of 6–12 months before the graft is no longer adherent to the underlying viscera. A simple "pinch test" can be done by pinching the skin graft between the index finger and thumb to confirm that it freely lifts from the viscera underneath (Fig. 73.7). Delaying too long has potential disadvantages as well. It has been suggested that a delay of longer than 12 months may be associated with increased loss of domain, making a tension-free repair more difficult. While a minimum mandatory waiting period is reasonable in order to allow intra-abdominal adhesions to soften, the ultimate timing of surgery will depend on the resolution of inflammation, nutritional status and overall fitness of the patient. Sound surgical judgment is paramount to success in these circumstances.

Fig. 73.7 The "pinch" test indicates that the overlying split thickness skin graft is no longer adherent to the underlying viscera

L. Several newer, non-operative, strategies have been investigated in the treatment of ECF. These include techniques utilizing technologies such as fibrin sealant, endoscopic clips, and fistula plugs. There is currently no valid evidence to support the wide spread application of these adjuncts. Most of the current literature is limited to sparse case reports. However, they do have some promise in very select circumstances. Fibrin sealant may expedite closure in the long, narrow, low output fistula. However, these fistulas would likely close spontaneously regardless, and there is no compelling data that fibrin sealant shortens duration to fistula closure. Similarly, the use of fistula plugs have been reported in select cases, again with very limited data demonstrating its efficacy. Endoscopic clips may have some utility in the repair of acute perforations and ECF, but likely has little application in the treatment of chronic fistula. While these techniques are intriguing, there is currently not enough evidence to support their broadened use.

M. Even in a perfectly optimized patient, abdominal wall reconstruction can be a complex and high-risk procedure fraught with complications. As expected, abdominal wall defects are generally more extensive with EAF compared to ECF, however the operative goals and general principles are similar. By this stage, patients are often understandably frustrated and anxious to have their restorative surgery and lives returned to normal. As such, they will often push for an expedited single-stage closure. However, continued patience during this stage will lead to a better chance of success. Definitive reconstruction may require a multi-stage approach with several extensive operations. It is important to manage patient expectations and communicate clear-defined goals with the patient and their family. There are no prospective trials comparing a single-stage to multi-stage approach, and there are theoretical benefits and limitations to each. Proponents of the single-stage approach cite advantage of avoiding the morbidity associated with multiple procedures and anesthetics. However, a "less is more" strategy will pay off in the long run and an overly aggressive surgical plan should be avoided. There is no question that when utilizing complex abdominal wall reconstructive techniques, the first attempt will be the one most likely of succeeding. Due the contaminated nature of these cases, it seems reasonable that performing the abdominal wall reconstruction remotely from repair of the fistula may result in fewer infectious complications, improved success rates, and decreased rates of hernia recurrence. While there are no prospective studies comparing single-stage to multi-stage reconstruction, numerous retrospective studies have demonstrated that a well thought out, staged reconstructive plan can result in low mortality with good long-term result. Clearly, correcting and avoiding whatever conditions led to the formation of the fistula in the first place is a cornerstone of any surgical strategy. One immediate goal is attaining abdominal wall closure over the visceral repair. Exposure of bowel to the environment results in high rates of re-fistulization and must be avoided at all costs.

N. There is no simple approach to abdominal wall reconstruction. Repair of the visceral component generally involves resection of the fistula-containing segment with primary anastomosis. With regard to repair of the

abdominal wall defect, many operative techniques have been described. Simple mesh underlay does provide acceptable hernia repair, but often results in abdominal wall laxity with lack of a functional anterior abdominal wall. This can limit functional recovery and have sub-optimal cosmetic results. Component separation techniques (CST) are technically challenging and carry significant risk of postoperative wound complications. The external oblique release involves division of the external oblique aponeurosis and separation of the external oblique muscle from the internal oblique and the rectus muscle from the posterior rectus sheath (Fig. 73.8a, b). This technique can result in medial fascial advancement of up to 10 cm at the waistline. This, coupled with mesh reinforcement can reconstitute a dynamic and functional abdominal wall (Fig. 73.9). Some defects are so large that a bridging mesh technique will still be required. Expectedly, this results in higher hernia rates. Additionally, several modified component separation techniques have been described that focus on decreasing local wound complications and hernia recurrence rates. These techniques include both laparoscopic and posterior approaches. With laparoscopic component separation, a balloon dissector is placed through a small incision just off the tip of the 11th rib and inflated to create a space behind the external oblique. A second laparoscopic port is then placed and the aponeurosis medial to the external oblique, as well as Scarpa's fascia, is released with electrocautery. The remainder of the repair is completed through a midline incision with methods identical to the standard open CST. Although, a completely laparoscopic technique has been described in which the rectus muscles are closed with interrupted sutures place via a suture passer. The laparoscopic approach avoids the morbidity associated with the large cutaneous flaps required of the traditional CST. Posterior component separation with transversus abdominis muscle release similarly does not require mobilization of large cutaneous flaps and is performed through a standard midline laparotomy incision. A retrorectus dissection is first performed by incising the posterior rectus sheath and a retromuscular plane is developed laterally, taking care to preserve the neurovascular bundle supplying the rectus. The ventral aspect of the posterior rectus sheath is incised revealing the fibers of the transversus abdominis muscle, which is then released along the length of the abdominal wall. A plane is developed between the transversus abdomi-

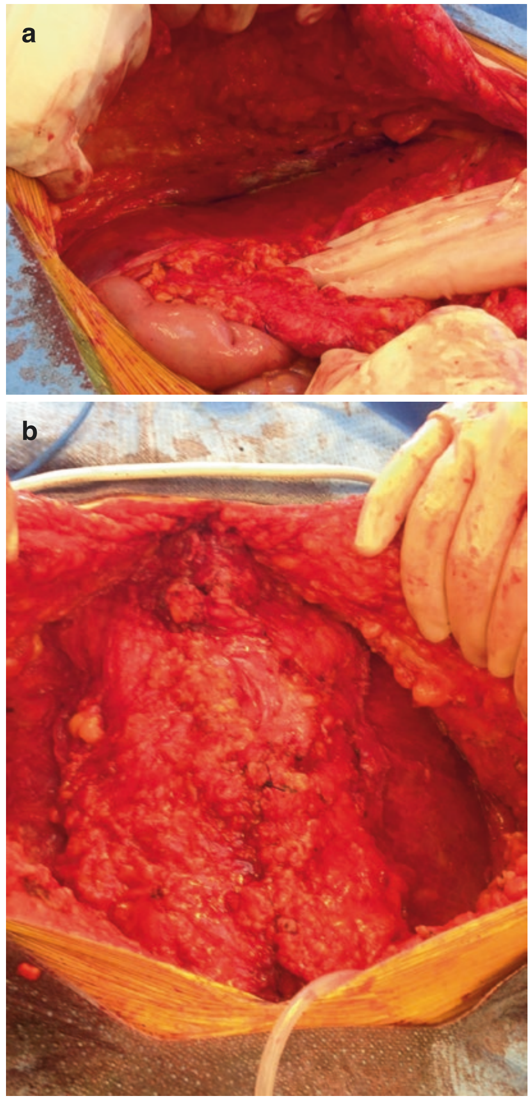

Fig. 73.8 (**a**, **b**) These photos show a completed external oblique release and midline closure

Fig. 73.9 A young, thin patient who had a large hernia preoperatively. He has clearly benefited from a functional abdominal wall reconstruction

nis muscle and the transversalis fascia laterally towards the retroperitoneum. The medialized posterior sheaths are then re-approximated and a retro-muscular sublay synthetic mesh is placed. While there are no prospective trials comparing these techniques to traditional CST, they likely are useful in avoiding some of the morbidity associated with procedure while maintaining the benefit of restoring a functional abdominal wall. Regardless of the surgical approach, it is important to remember that the operative management is only one component of the management of these exceedingly complex patients, and multidisciplinary support is essential to achieve a successful outcome.

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74 Small Bowel Polyps

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Refer to Algorithm in Fig. 74.1

A. **Small Bowel Polyps, What They Are and Presentation**
Small bowel polyps are abnormal growths of tissue that can include benign and malignant types of multiple different histologic classifications. Histologic types include hamartomatous, hyperplastic, inflammatory, adenomatous, and malignant (intrinsic and metastatic from distant sites). The presentation is variable and not always straightforward due to the rarity of the diagnosis and the nonspecific nature of the symptoms. Presenting symptoms can include abdominal pain, nausea and emesis, bowel obstruction, and gastrointestinal hemorrhage. Occasionally, small bowel polyps are asymptomatic and found incidentally or on screening examinations. Once symptoms are present, the diagnosis is often delayed.

B. **Small Bowel Polyps Presentation: Family History, Obstruction, Intussusception, Bleeding**

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In addition to the often nonspecific symptoms that patients with small bowel polyps present with, patients often have other elements of their history, physical and diagnostic testing that could lead to the diagnosis. Patients may have a family history or personal history of small bowel polyps or a known polyp-forming syndrome. Obstructive symptoms can develop from large lesions creating a mechanical obstruction or from the lesions acting as a lead point for intussusception. Bleeding from small bowel pathology can be occult or clinically obvious. The evaluation of lower gastrointestinal bleeding is often nondiagnostic in these cases, so a high index of suspicion should be kept. This will lead to the utilization of alternative imaging to assess the small bowel, such as CT angiography, small bowel enteroscopy, pill camera endoscopy or small bowel contrast studies.

C. **Diagnosis: Pill Cam Endoscopy, Double Balloon/Push Enteroscopy, CT and MRI Enterography, Small Bowel Follow-Through**
The major problem with diagnosing small bowel polyps or pathology is the relative inaccessibility of the small bowel to traditional investigative techniques. Additionally, the incidence of small bowel pathology is relatively low compared to the colon or foregut and because of this, there is often a delay in diagnosis. Small bowel polyps can be

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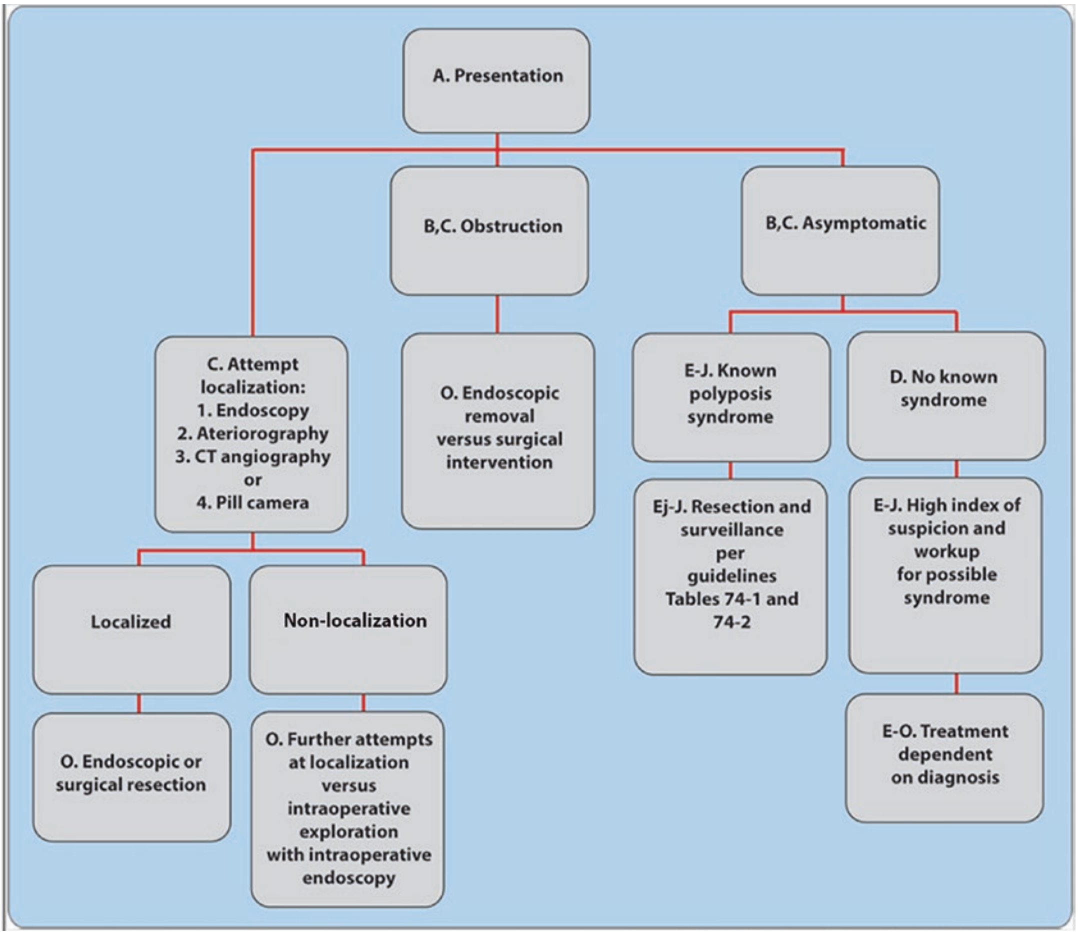

Fig. 74.1 Algorithm for small bowel polyps

diagnosed with multiple different modalities, depending on the patient's presenting symptoms. When found incidentally, it is typically with either cross-sectional imaging or on endoscopy for another indication. When small bowel polyps are suspected, practitioners will often have preferences for using different modalities, depending on availability of tests, equipment and expertise or the clinical scenario. Small bowel-follow through or enteroclysis can be useful for diagnosis but may miss small lesions and are not therapeutic tests. Similarly, computed tomography (CT) enterography and magnetic resonance imaging (MRI) enterography can be diagnostic but not therapeutic. Some advocate pill camera endoscopy for its low risks; however, the disadvantage is that this test is also diagnostic but not therapeutic. Double balloon or push enteroscopy is another useful modality that can be diagnostic and also therapeutic. All modalities have a missed lesion rate so the choice in diagnostic procedure should be made on a case-by-case basis. Often using multiple techniques in the same patient can be complimentary.

D. **Spontaneous Small Bowel Polyps**
Small bowel polyps in the absence of a genetic syndrome or other underlying inflammatory disease of the small bowel are quite rare, seen in <1% of autopsies. Although greater than 60% of these are benign, many never come to clinical attention if the patient is without symptoms. The most common

benign histologic types are adenomas, leiomyomas, lipomas, Brunner's gland adenomas, lymphangiomas and fibromas or inflammatory polyps. Surgical resection should be considered for spontaneous small bowel polyps that become symptomatic, are >1 cm in size or if there is a concern for malignancy. They can be resected endoscopically if accessible, with a segmental resection or with an enterotomy and polypectomy.

E. **Small Bowel Polyps and FAP**
Familial Adenomatous Polyposis (FAP) is an autosomal dominant germline mutation in the Adenomatous polyposis coli (APC) gene. This syndrome manifests as hundreds of colonic polyps at a young age, with almost all patients progressing to colon carcinoma in absence of colectomy. The syndrome also manifests with duodenal and other small bowel polyps. Duodenal polyps occur in up to 90% of these patients and jejunal and ileal polyps occur in >50%. Duodenal carcinoma is the leading cause of death in patients with FAP who have undergone colectomy, occurring in approximately 5–10% of patients. Current guidelines recommend screening upper endoscopy at age 20–25 and then repeat exams every 6 months to 4 years depending on the findings of the initial exam (determined by the Spigelman criteria), Tables 74.1 and 74.2. Patients who have undergone proctocolectomy with ileal pouch anal anastomosis can also develop small bowel polyps within their pouch. For this reason, endoscopic surveillance of the pouches in these patients is recommended every 1–3 years (Fig. 74.2).

F. **Small Bowel Polyps and MUTYH-Associated Polyposis (MAP)**
MutYH-associated polyposis (MAP) is an autosomal recessive condition associated with biallelic mutations in MUTYH. The phenotype for MAP is variable and does not always present with polyposis. The colorectal cancer risk in this patient population is around 75%. Approximately 20% of this patient population will develop duodenal polyps and duodenal cancer will occur in 5% of patients with the disease. If a patient has known MAP, current guidelines recommend screening for duodenal polyps starting at age 30 and repeated every 3–5 years if initial examination is normal. If polyps are noted, the screening should follow the FAP guidelines by Spigelman criteria (Table 74.2).

G. **Small Bowel Polyps and HNPCC/Lynch Syndrome**
Hereditary Nonpolyposis Colorectal Cancer (HNPCC) or Lynch Syndrome is an autosomal dominant cancer syndrome due to mutations in mismatch repair (MMR) genes. The syndrome clinically can manifest with multiple different carcinomas including colorectal, endometrial, ovarian, breast, prostate, urinary tract, hepatobiliary, central nervous system, gastric, and small bowel. The risk of small bowel carcinoma in Lynch syndrome is reported to be anywhere from 0.4% to 12% compared to <1% in the general population.

Table 74.1 Spigelman staging for duodenal polyps in FAP patients, also used with MAP patients

Points	1	2	3
Number of polyps	1–4	5–20	>20
Polyp size (in mm)	1–4	5–10	>10
Histology	Tubular	Tubulovillous	Villous
Dysplasia	Mild	Moderate	Severe
Spigelman stage (points)	*Repeat endoscopy*		
Stage 0 (0)	5 years		
Stage I (1–4)	5 years		
Stage II (5–6)	2–3 years		
Stage III (7–8)	6–12 months		
Stage IV (9–12)	Consider surgical evaluation		

Table 74.2 Syndromes and screening recommendations for small bowel polyps

Syndrome	Start screening	Type	Interval
Familial Adenomatous Polyposis (FAP)	20–25 yo	EGD	Per Spigelman criteria
MutYH-associated polyposis (MAP)	30 yo	EGD	Every 3–5 years—OR—Per Spigelman criteria
Lynch Syndrome	No recommendation	N/A	No recommendation
Peutz-Jeghers	8–10 yo	Small Bowel evaluation (CT or MRI enterography)	Again 18 yo, then 2–3 years
	Late teens	EGD	Every 2–3 years
Juvenile Polyposis Syndrome	15–25 yo	EGD	Every 2–3 years
PTEN Hamartoma Tumor Syndrome (PHTS)	No recommendation	N/A	No recommendation

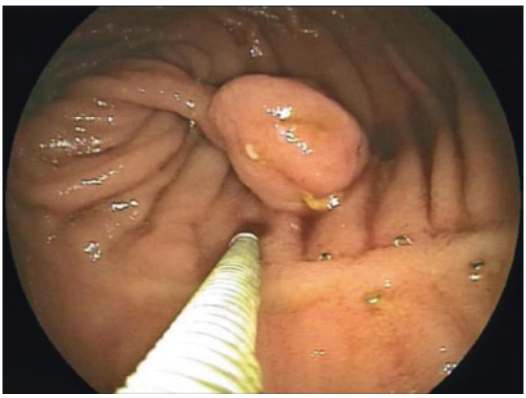

Fig. 74.2 Small bowel polyp in an ileo-anal pouch. (Photo courtesy of Dr. Brintha Enestvedt)

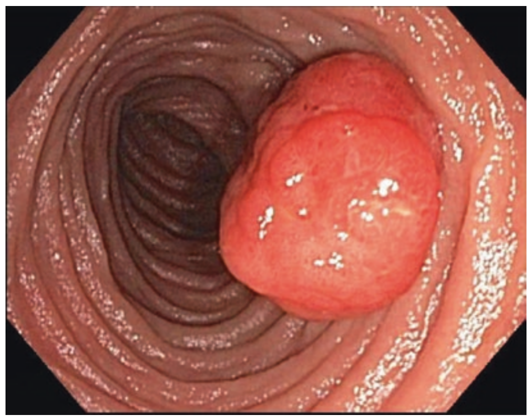

Fig. 74.3 Peutz-Jeghers small bowel polyp. (Photo courtesy of Dr. Brintha Enestvedt)

Due to the rarity of small bowel carcinoma in Lynch syndrome, screening testing is not currently recommended outside of high-risk Asian populations. Clinicians, however, should maintain a high level of suspicion if symptoms arise in these patients (Table 74.2).

H. **Small Bowel Polyps and Peutz-Jeghers**

A hamartoma is a nonneoplastic growth of inherently present tissue type. Hamartomas in themselves are benign lesions but their presence may indicate an inherited hamartomatous polyposis syndrome. Peutz-Jeghers is one of these syndromes, caused by a mutation in the STK11 gene. The most common place for Peutz-Jeghers patients to develop polyps is within the small bowel, but these patients can also develop polyps throughout the entire gastrointestinal tract (Fig. 74.3). Peutz-Jeghers hamartomas arise from the muscularis mucosa. Patients often have very few polyps (<20) but these polyps can often be large and cause symptomatic bowel obstructions or hemorrhage. The syndrome is also associated with mucocutaneous pigmentation changes. Although the polyps in Peutz-Jeghers syndrome are benign, these patients have a very high (>90%) risk of developing cancer in their lifetime (including colorectal cancer, pancreatic cancer, gastric cancer and breast cancer). It is thought that patients with Peutz-Jeghers have a risk of malignant transformation of their benign hamartomatous polyps to adenocarcinomas. Small bowel

carcinoma is estimated to occur in 13% of these patients within their lifetime. In patients with known Peutz-Jeghers syndrome it is recommended for small bowel evaluation to first occur at age 8–10. This evaluation can be performed with CT enterography or MRI enterography. If the examination is normal, this should be repeated at age 18 and then every 2–3 years thereafter. In addition to full small bowel evaluation esophagogastroduodenoscopy should also be performed starting in a patient's late teens and continuing every 2–3 years thereafter (Table 74.2).

I. **Juvenile Polyposis Syndrome**

Juvenile Polyposis Syndrome (JPS) is a hamartomatous polyposis syndrome characterized by juvenile hamartomatous polyps, which arise from the lamina propria layer of the intestines and contain mucin-filled spaces. These polyps can occur throughout the entire gastrointestinal tract. Polyp symptoms are often secondary to gastrointestinal hemorrhage. Patients with juvenile polyposis syndrome can also have other congenital malformations such as cranial, renal and cardiac malformations. The underlying genetic abnormality is a mutation in either BMPR1A or SMAD4 which is inherited in an autosomal dominant fashion. These patients have a 50% risk of developing colorectal cancer and an approximately 15–20% risk of developing duodenal cancer. Screening for duodenal polyps is recommended to begin between ages 15 and 25 and repeat every 2–3 years (Table 74.2).

J. **PTEN Hamartoma Tumor Syndrome (PHTS)**

PTEN Hamartoma Tumor Syndrome (PHTS) is a hamartomatous polyp syndrome that includes Cowden syndrome and Bannayan-Riley-Ruvalcaba syndrome (BRRS). Both of these syndromes are defined by abnormalities in the PTEN gene and characterized by multiple hamartomas. Patients can have a variety of manifestations of their disease to include macrocephaly, trichilemmomas (benign cutaneous neoplasm) and malignancies including thyroid, endometrial and renal carcinoma. Patients with Cowden syndrome manifest in their adulthood years whereas patients with BRRS manifest in childhood with developmental delay. There is debate as to whether or not these syndromes in fact represent the same entity with different ages of presentation. Regardless of the age of onset, all of these patients are at risk of hamartomatous lesions of the gastrointestinal tract. Patients often have multiple hamartomas, especially in the ileum and colon. These hamartomas can become symptomatic with bleeding or obstruction but are not known to degenerate to cancerous lesions. PHTS patients, however, do have a higher risk of colorectal cancer than the general population. There are no current guidelines for screening or surveillance of the small bowel in these patients (Table 74.2).

K. **Small Bowel Adenocarcinoma**

Small bowel adenocarcinoma is quite rare but does account for approximately 30% of all small bowel tumors. The duodenum is the most common site of small bowel adenocarcinomas. For unclear reasons, small bowel adenocarcinomas are more prevalent in males than females. Diagnosis is often difficult and delayed due to vague presenting complaints and lack of routine screening.

L. **Small Bowel Carcinoid**

Carcinoids are neuroendocrine tumors that originate from enterochromaffin cells (Fig. 74.4). Small bowel carcinoids are an increasingly more commonly diagnosed

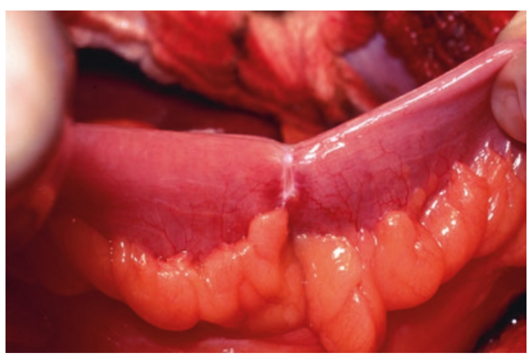

Fig. 74.4 Small Bowel Carcinoid. (Photo courtesy of Dr. Rodney Pommier)

tumor. It is unclear if this is more recognized, increasing in incidence, or both. Small bowel carcinoids have now surpassed small bowel adenocarcinoma as the most common small bowel malignancy. Carcinoid tumors are generally indolent and slow-growing. The mainstay treatment is surgical resection, which can be beneficial even in the setting of metastatic disease. It is important for clinicians to keep in mind that those patients with a small bowel carcinoid are also at an increased risk of having a second primary tumor, whether another carcinoid tumor or another type, including colorectal cancer and breast cancer. The overall incidence of second primary in these patients is 30–50%.

M. **Small Bowel Lymphoma**

Small bowel lymphoma can be associated with celiac sprue or immunosuppressed patients, including transplant patients and patients with human immunodeficiency virus (HIV). The most common site of gastrointestinal lymphoma is gastric, followed by the small bowel as the second most common site. At times it is difficult to determine if the lymphoma is a primary small bowel lesion or a secondary lesion of a distant primary. Unlike gastric lymphoma that often responds to treatment of Helicobacter pylori infection, the mainstay treatment of small bowel lymphoma is resection and chemotherapy. B-cell lymphomas are more common and have a better prognosis than T-cell lymphomas.

N. **Crohn's Disease—Inflammatory Polyps and Cancer**

Crohn's disease (CD) is a variant of inflammatory bowel disease which can affect anywhere within the gastrointestinal tract from the oral cavity through the anus. Patients with Crohn's disease have a 10–12-fold risk of small bowel adenocarcinoma compared to the general population. The overwhelming majority of small bowel carcinoma in CD patients occurs in the ileum, which is also the most common location for CD inflammation to occur. Unfortunately, this often leads to delay in diagnosis as symptoms from tumor mass can be mistaken for active inflammation of the underlying CD. Clinicians treating patients with CD must have a high index of suspicion for adenocarcinoma in these patients.

O. **Treatment**

Polyps that are symptomatic, >1 cm in size and with a concern for malignancy need to be resected. Options for resection are endoscopically, surgically, or a combination of both (Fig. 74.5). The underlying cause of the small bowel polyp(s) and their presentation will determine the optimal approach. Sporadic polyps that can be reached endoscopically can be adequately treated with polypectomy. However, if a sporadic polyp is causing obstruction, intussusception, or cannot be reached endoscopically, segmental small bowel resection is required. Polyps associated with hereditary conditions create a more challenging scenario because of the potential for multiple polyps throughout the small bowel. In these cases, a combination of surgical exploration and intra-operative endoscopy is required to assess the entire small bowel. After the abdomen is opened and the small bowel has been assessed, a long small bowel endoscope is introduced and fed along the small bowel to localize the polyps. Small polyps can be resected endoscopically and larger polyps can be resected via segmental resection or an enterotomy can be created to

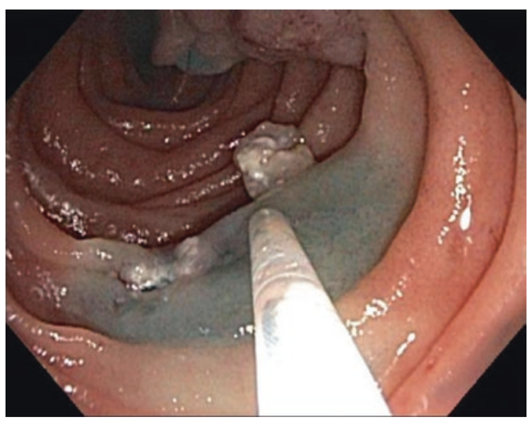

Fig. 74.5 Endoscopic removal of small bowel polyp. (Photo courtesy of Dr. Brintha Enestvedt)

perform a polypectomy. The benefit of combining surgical exploration with endoscopy is the ability to assess and treat polyps along the entire small bowel. Finally, limited data suggests the use of cyclooxygenase (COX) inhibitors in patients with small bowel polyposis syndromes in attempt to lessen the polyp burden. The benefits of the use of these medications, however, need to be weighed against the risks of the medications.

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Small Bowel Lymphoma

75

Mahmoud Abu Gazala and Alon J. Pikarsky

Refer to Algorithm in Fig. 75.1

A. Lymphomas of the small intestine are very rare, representing around 30% of all lymphomas in the gastrointestinal tract, and less than 0.5% of all gastrointestinal tract malignancies. Most lymphomas of the small intestine represent an extra-nodal involvement of a systemic disease. As much as 5–20% of patients with lymphoma may have secondary extra-nodal involvement of the small bowel, dependent on the stage of the disease. The most common site of involvement is the ileum followed by jejunum.

B. Histologically, most lymphomas of the small intestine are B-Cell derived, while less than 10% are T-cell Lymphomas and Hodgkin lymphoma. The lymphomas of the small intestine can be categorized into three groups:
   1. Immunoproliferative small intestinal disease (IPSID) is a MALT-associated lymphoma arising in the small bowel, which is due to *C. jejuni* infection and characterized by monoclonal plasma cells secreting immunoglobulin alpha heavy chain (thus also known as alpha heavy chain disease αHCD). IPSID is typical for the middle-east and Mediterranean region, accounting for approximately 75% of the primary GI lymphomas in that area. It also typically affects a younger age population, with median presentation age of 25 years.
   2. Enteropathy-associated T cell lymphoma (EATL) is highly associated with gluten-sensitive enteropathy (celiac sprue), and thus is most common in Western parts of Ireland and Northern Europe. EATL typically affects adult males in their sixth decade of life.
   3. Non-IPSID Western lymphomas, include other less prevalent lymphomas such as diffuse large B cell lymphoma, Burkitt's lymphoma, follicular lymphoma and mantle cell lymphoma. An association has been described between inflammatory bowel disease (IBD), especially patients treated with immunosuppression (azathioprine and 6MP), and development of Epstein-Barr virus associated lymphoma of the small intestine.

C. The pattern of involvement of the small bowel, and thus the clinical presentation, differs between the subtypes. IPSID tends to have a diffuse involvement of the proximal bowel with a disseminated nodular pattern with wall thickening and irregularity. This is responsible for the clinical manifestations of abdominal pain, malabsorption, diarrhea and weight loss. EATL usually is more localized, appears on

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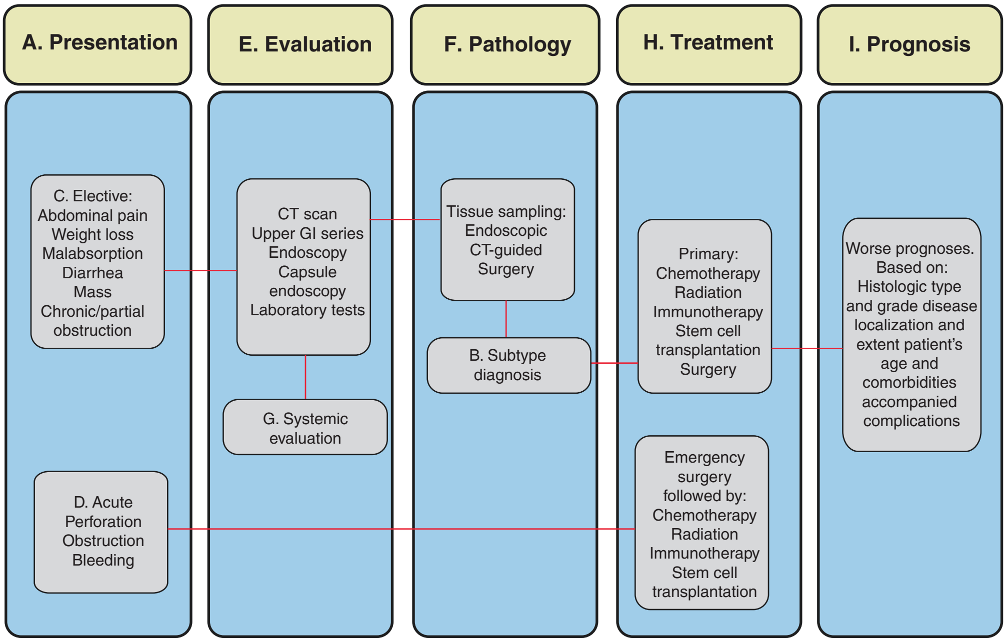

Fig. 75.1 Algorithm for small bowel lymphoma

endoscopy as multiple raised, ulcerated mucosal nodules or as a solitary exophytic mass. Clinical presentation is often of acute bleeding, obstruction, or perforation. Additionally, presenting with a palpable mass and GI bleeding are also possible manifestations.

Other types of lymphomas have a more non-specific presentation, including abdominal pain, GI bleeding, intestinal obstruction or perforation and an abdominal mass. Burkitt's lymphoma is typically much more prevalent in Africa, is associated with AIDS and EBV infection, and usually presents as a distal obstructing mass in the ileum.

D. Rarely, a lymphoma of the small intestine presents acutely with perforation and peritonitis, bowel obstruction or bleeding. However, most patients manifest with other symptoms over a variable period of time (*i.e.,* weeks to years), allowing a more thorough evaluation prior to treatment.

E. The diagnostic evaluation for a suspected lymphoma of the small intestine may include a contrast-enhanced computerized tomography (CT), upper GI series with small bowel follow-through, upper and lower endoscopy with double-balloon enteroscopy, and capsule endoscopy. Positron emission tomography (PET) is of controversial role in the evaluation of lymphomas of the small intestine. Suggestive findings on the diagnostic studies may depend on the specific lymphoma subtype, and may include wall thickening of the small bowel, mucosal ulcerations, bleeding, nodules and masses with or without obstruction, intussusception, fistulas and mesenteric or retroperitoneal lymphadenopathy.

Laboratory evaluation is non-contributive in most cases, except with IPSID, where α heavy chain may be detected in most patients. HIV testing is recommended to rule out AIDS-associated lymphomas.

F. Final diagnosis could be confirmed via an endoscopic or CT-Guided biopsies. In certain cases, surgical exploration and biopsies are warranted when other modalities are non-diagnostic.

G. Systemic evaluation is of utmost importance in order to distinguish between primary intestinal lymphomas and secondary intestinal involvement of a systemic disease.

Diagnostic laparoscopy/laparotomy is indicated when the above mentioned investigative evaluation is non-diagnostic.

H. Treatment strategy for small bowel lymphoma is dependent on the specific setting, mainly the clinical scenario, disease burden and extent of involvement of the small bowel, lymphoma subtype, comorbidities and other factors.

The mainstay of therapy for intestinal lymphomas is typically a combination of chemotherapy, radiotherapy, immunotherapy and surgery. Stem cell transplantation may also be offered in specific cases.

Surgical resection as a primary modality of treatment is reserved for localized disease, acute complications such as obstruction, bleeding or perforation. Surgery as the sole treatment for intestinal lymphoma is reserved only for low grade localized intestinal lymphoma. Adjuvant therapy is usually indicated for all other cases. Radiotherapy is less useful in lymphomas of the small intestine due to multifocality and adjacent intestinal toxicity. Palliative surgery may be indicated for advanced cases for treatment of complications such as diversion, bypass or debulking procedures. Surgery may also be used as a diagnostic modality in specific case. Surgery has limited role in the treatment of IPSID due to the diffuse involvement nature of the disease; however, may be required for diagnosis or for treatment of complications. On the other hand, surgery plays a bigger role in the treatment of EATL due to poorer response to chemotherapy alone and risk for perforation. Surgical resection of lymphoma mass or debulking procedures improve overall response rates when combined with chemotherapy and stem cell transplantation.

I. Prognosis in lymphoma of the small intestine are generally poorer compared to other types of lymphomas. Histologic type and grade, disease localization and extent, patient's age and comorbidities and accompanied complications all play a significant role in determining prognosis. In general, EATL have poor clinical outcomes with a 5-year survival of less than 20%. IPSID may be cured in early stages, however transformation to more aggressive forms is possible. Burkitt's lymphoma is chemo-sensitive and high rates of remission may be achieved with or without combination of surgery.

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Small Bowel Conditions: Carcinoid

76

Ahmed AL-Khamis and Patricia Sylla

Refer to Algorithm in Fig. 76.1

A. Gastrointestinal carcinoids were first described by Lubarsch in 1888 and in 1907 Oberndorfer coined the term Karzinoide to indicate the carcinoma-like appearance and presumed lack of malignant potential. Carcinoids can occur anywhere along the gastrointestinal tract (GI) and are generally classified according to their embryological origin as foregut (6%); [thymus, bronchopulmonary, stomach, duodenum, and pancreas], midgut (62%); [small intestine, appendix, and the right colon], and hindgut carcinoids (30%); [distal colon and the rectum] (Table 76.1). Thirty-five percent of all carcinoids arise in the appendix which is the most common location followed by the small bowel where 23% of tumors are located within 2 ft of the ileocecal valve, and the rectum which harbors the remaining 20% of all GI carcinoids. Approximately 25% of patients with foregut and midgut carcinoids will develop a synchronous tumor, usually adenocarcinoma of the large bowel, while hindgut carcinoids rarely concur with synchronous tumors. Carcinoid neoplasms can occur as part of inherited neoplastic syndromes such as neurofibromatosis or multiple endocrine neoplasia type I (10%) although the majority occur sporadically.

B. Small bowel carcinoids commonly present as the lead point in bowel obstruction or with chronic mesenteric ischemia from carcinoid-induced idiopathic mesenteric and retroperitoneal fibrosis that progressively encases and obstructs arterial inflow. They are typical multicentric, located in the terminal ileum, and most will present with lymph node or liver metastasis despite their relatively small size (less than 0.5 cm), as tumor size has been shown to correlate poorly with distant spread. Appendiceal carcinoids can present with abdominal pain, bowel obstruction, or as an incidental finding on pathological review following appendectomy. They are rarely multicentric, 95% are less than 2 cm in size and 75% are located in the distal third of the appendix. Tumor size is the strongest predictor of distant metastasis, with smaller tumors (<2 cm) less likely to metastasize to regional lymph nodes than larger tumors (>2 cm), which are more likely to present with metastasis. Hindgut carcinoids including colonic and rectal tumors, are non-secretory tumors and almost always asymptomatic with 50% diagnosed incidentally on pathological review of polypectomy specimens following

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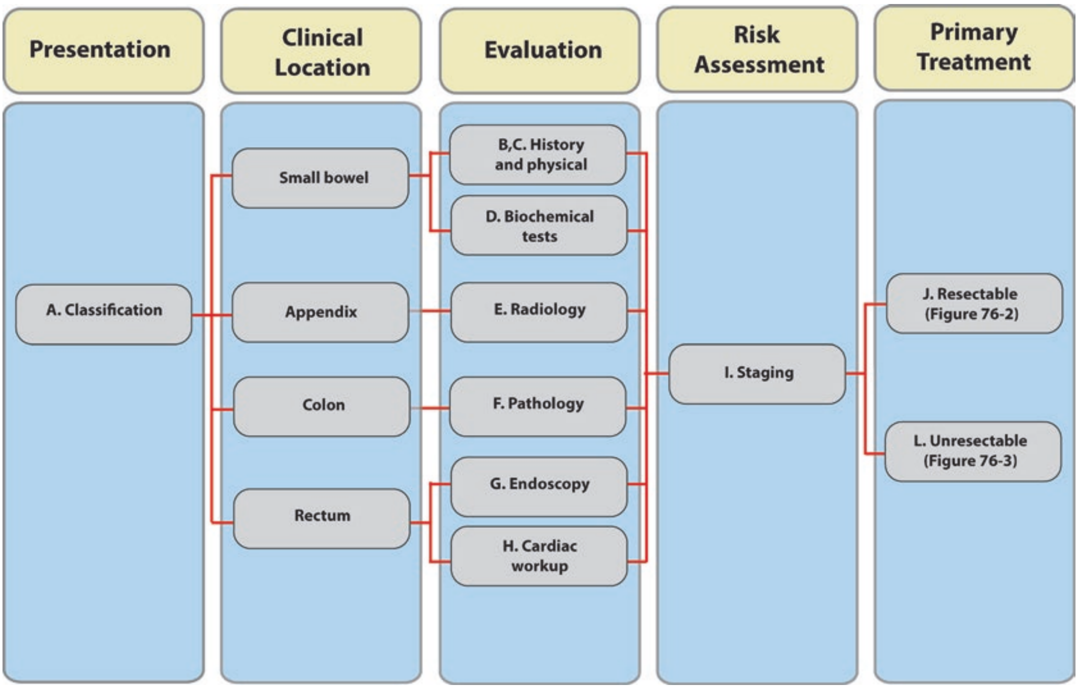


Fig. 76.1 Algorithm showing management of small bowel carcinoids

Table 76.1 Features and characteristics of carcinoid tumors based on embryological origin

Characteristics	Foregut	Midgut	Hindgut
Location	Thymus, bronchus, stomach, duodenum and pancreas	Jejunum, ileum, appendix	Colon, rectum
Proportion relative to all carcinoids	6%	62%	7%
Clinical features	Bleeding, carcinoid syndrome	Bowel obstruction, appendicitis, carcinoid syndrome	Incidental, obstructive symptoms, tenesmus, bleeding
Secretion			
Tumor 5-HT	Low	High	None
Urinary 5-HIAA	High	High	Normal
Carcinoid syndrome	+	+	–
Other endocrine secretions	+	+	–

5-HT; 5-hydroxytryptamine or serotonin
5-HIAA; 5-hydroxyindoleacetic acid

routine colonoscopy. Occasionally, larger tumors will present with obstructive symptoms, tenesmus and rectal bleeding. Physical examination is typically unremarkable, though a general physical examination should be performed to look for concomitant pathology, adenopathy or comorbid conditions. Similar to appendiceal carcinoids, tumor size correlates with the risk of distant metastasis, where tumors <1 cm have a 5% or less chance to metastasize (Table 76.1).

C. Carcinoid syndrome has been the hallmark of carcinoid neoplasms, however, only 20% of patients with local disease and 50% of patients with advanced disease actually develop this syndrome. Carcinoid syndrome is usually caused by both high levels of biologically active compounds secreted by the

tumors into the systemic circulation causing episodic symptoms, including serotonin, hydroxytryptophan, prostaglandins, histamine, and bradykinin, as well as by the propensity of these tumors to metastasize to the liver, hindering the liver ability to degrade these biological active compounds into inactive by-products. Midgut carcinoids are most commonly associated with carcinoid syndrome as midgut tumors tend to produce high levels of serotonin. Foregut carcinoids, on the other hand, lack the enzyme required to convert chemical precursors such as 5-hydroxytryptophan into serotonin, so it is uncommon for them to result in carcinoid syndrome. Hindgut carcinoids are usually non-functional and rarely produce serotonin or the enzymes necessary to produce serotonin, and hence rarely produce the carcinoid syndrome, even when they metastasize to the liver. Symptoms of carcinoid syndrome include abdominal pain, non-bloody diarrhea, flushing, sweating and valvular heart disease (pulmonary stenosis, tricuspid insufficiency, and tricuspid stenosis) (Table 76.2). Carcinoid crisis is a life-threatening condition characterized by severe abdominal pain, flushing, hypotension, or hypertension. It can be precipitated by stress such as anesthesia and surgery. In the setting of a carcinoid crisis, symptoms are usually managed with short-acting octreotide (Section K). Octreotide prevents and treats carcinoid syndrome by activating two out of five know somatostatin receptors identified within carcinoid tumors, subtypes 2 and 5. Activation of these receptors results in the reduction in the synthesis and secretion of serotonin, hydroxytryptophan, and other biologically active compounds.

Table 76.2 Clinical symptoms of carcinoid syndrome

Symptom	Causative tumor product
Flushing	Bradykinin
	Hydroxytryptophan
	Prostaglandins
Telangiectasia	Vasoactive intestinal polypeptide
	Serotonin
	Prostaglandins
	Bradykinin
Bronchospasm	Bradykinin
	Histamine
	Prostaglandins
Endocardial fibrosis	Serotonin
Glucose intolerance	Serotonin
Arthropathy	Serotonin
Hypotension	Serotonin

D. 5-Hydroxyindoleacetic acid (5-HIAA) 24-h urine test is the most commonly used diagnostic test for carcinoid tumors with a 29–92% sensitivity and a 79–100% specificity. This compound is excreted in the urine after serotonin metabolism by the liver and lung to a pharmacologically inactive 5-HIAA. Prior to performing this test, patients should avoid serotonin-rich foods such as pineapples, kiwi, nuts, bananas and some medications that may result in falsely elevated urine 5-HIAA levels. Serum Chromogranin A (CgA), which is elevated in in 80% of patients with carcinoids tumors, is another useful marker with a sensitivity of 73% (range, 32–92%) and specificity of 95% (range, 63–100%). Circulating CgA levels reflect tumor load and can provide early diagnosis of persistent or recurrent carcinoid disease, with studies reporting that in over 80% of patients, serum elevation of CgA precedes the clinical diagnosis of recurrence by up to 2 years. This makes this marker valuable for monitoring the extent of disease and for long-term follow-up. The Ki67 antigen is a nuclear protein expressed by proliferating carcinoid cells and is absent in resting cells. Ki67 expression can be tested in resected tumors specimens using anti-Ki67 antibodies. Tumor levels of Ki67 expression can help predict response to chemotherapy. Low values (<2% tumor expression levels) indicate a low likelihood of clinical downstaging with chemotherapy whereas, high values (>2% tumor expression levels) suggest that tumors are more likely to benefit from chemotherapy in conjunction with surgery.

E. Radiologic staging of carcinoid tumors is performed using computerized tomography scans (CT) and magnetic resonance imaging (MRI)

of the chest, abdomen and pelvis. The diagnostic sensitivity for carcinoids ranges 57–94% with CT and 85–94% with MRI. Somatostatin receptor scintigraphy (SRS) is a whole body nuclear imaging study that is useful for localizing carcinoid tumors that express somatostatin receptors (SSTR 1–5), with a sensitivity that ranges 57–85% and specificity reported as high as 90% for localizing carcinoid tumors that express somatostatin receptors (SSTR 1–5). It is commonly used to rule out occult metastases when curative resection is intended. Furthermore, it may also be used to direct the choice of therapy (e.g. use of the somatostatin analogues in patients with unresectable tumors). Meta-iodobenzylguanidine scan (MIBG) is another nuclear imaging study that has been increasingly recommended as a diagnostic test for carcinoids tumors. Since about 10% of carcinoids do not express somatostatin receptors, but do occasionally take up Meta-iodobenzylguanidine rather than octreotide, MIBG scan be useful to detect carcinoids lesions that appeared negative on SRS scan. Most recently, whole body positron emission tomography scan (PET) with serotonin precursor 5-hydroxytryptophan, labelled with 11C (5HTP-PET) has been associated with high diagnostic sensitivity, and described as a helpful adjunct to monitor the effects of therapy.

F. On gross examination, carcinoids appear as small submucosal (less than 2 cm in size), multicentric, yellow colored tumors on cut surface due to their high lipid content. However, they may also appear as subtle small white colored plaques on the antimesenteric border of the small or large bowel. They are typically associated with desmoplastic invasion and fibrosis of the mesentery caused by local effects of serotonin, growth factors, and other released substances, which can appear as large mesenteric masses often mistaken for the primary tumor. On microscopic examination, carcinoid tumors appear as round uniform cells packed with various secretary peptides. There are five histologic patterns which include insular, trabecular, glandular, undifferentiated, and mixed types. Histological features of aggressive carcinoid tumors include increased cellular atypia, necrosis and/or high mitotic rate.

G. Upper and lower GI endoscopy should be considered especially in patients with midgut carcinoids as they tend to have high rate of synchronous tumors in regions remote from the primary tumor, particularly adenocarcinoma of the large bowel, where this has been reported in up to 6–15% of patients.

H. Prior to any elective resection electrocardiogram and echocardiogram should be performed in both symptomatic and asymptomatic patients to rule out carcinoid valvular disease, a potential complication of carcinoid syndrome.

I. Using the diagnostic tests and imaging modalities discussed earlier, carcinoids tumors are staged using the American Joint Committee on Cancer staging system (Tables 76.3, 76.4 and 76.5) to guide the multidisciplinary treatment and optimize surgical and/or systemic therapies. Furthermore, the world health organization (WHO) grading system, which is used to grade GI pancreatic neuroendocrine and carcinoid tumors and is based on the degree of tumor differentiation, tumor mitotic rate, Ki67 expression and presence or absence of ulceration, can be helpful in assessing tumor aggressiveness, predict tumor response to specific therapies and optimize treatment approach for each individual case (Table 76.6).

Refer to Algorithm in Fig. 76.2

J. The surgical treatment of carcinoid tumors is based on tumor location, local, regional and distant extent of disease. For small bowel carcinoids where tumor size does not correlate with lymph node or distant metastasis, oncologic resection of the small bowel and associated mesenteric lymph nodes is the standard of care. Moreover, the entire small intestine should be carefully examined to exclude possible synchronous tumors. In addition, the proximity and or involvement of the superior

Table 76.3 Table American Joint Committee on Cancer (AJCC) 8th edition, small bowel

Stage	features	
Primary tumor (T)		
Tx	Primary tumor cannot be assessed	
T0	No evidence of primary tumor	
T1[a, b]	Tumor invades lamina propria or submucosa and size less than or equal to 1 cm	
T2[a, b]	Tumor invades muscularis propria or size more than 2 cm	
T3[a, b]	Tumor invades through the muscularis propria into the subserosa without penetration of the overlying serosa	
T4[a, b]	Tumor invades peritoneum (serosal) or other organs or adjacent structures	
Regional lymph nodes (N)		
Nx	Regional lymph nodes cannot be assessed	
N0	No regional lymph node metastasis	
N1	Regional lymph node metastasis less than 12 nodes	
N2	Large mesenteric mass (over 2 cm) and/or extensive nodal deposits (12 or more), especially those that encase the superior mesenteric vessels	
Distant metastasis (M)		
M0	No distant metastases	
M1	Distant metastasis	
M1a	Metastasis confined to liver	
M1b	Metastasis in at least one extrahepatic site (e.g. lung, ovary, nonregional lymph node, peritoneum, bone)	
M1c	Both hepatic and extrahepatic metastasis	
Stage grouping		
Stage		5 year survival
Stage I	T1, N0, M0	96–100%
Stage II	T2, N0, M0	87–100%
	T3, N0, M0	
Stage III	T1, N1, N2, M0 T2, N1, N2, M0 T3, N1, N2, M0 T4, N0, M0	74–91%
	T4, N1, N2, M0	
Stage IV	Any T, Any N, M1	43–72%

[a]*Note:* For any T, add (m) for multiple tumors [TX(#) or TX(m), where X = 1–4, and # = number of primary tumors identified∗∗]; for multiple tumors with different T, use the highest

[b]*Example:* If there are two primary tumors, only one of which invades through the muscularis propria into subserosal tissue without penetration of overlying serosa (jejunal or ileal), we define the primary tumor as either T3(2) or T3(m)

mesenteric artery and vein should be assessed during surgery. For appendiceal carcinoids where tumor size correlates with metastatic potential, tumors <1 cm are treated with simple appendectomy while tumors >2 cm, which are associated with a 30–60% rate of positive lymph nodes and distant metastasis, should be treated with radical right hemicolectomy. Tumors 1–2 cm in size, in which the risk of metastasis is 0–1%, should be treated with primary or salvage right hemicolectomy if the base of the appendix is involved, if there is tumor extension to the mesoappendix or subserosal lymphatics, or if goblet cells are present on pathology. Rectal carcinoids <1 cm can be treated with local excision, either endoscopically, using transanal excision (TAE) or transanal endoscopic surgery (TES). Tumors >2 cm are treated with radical proctectomy, either low anterior resection or abdominoperineal resection with total mesorectal excision (TME). For rectal lesions 1–2 cm in size, the risk of lymph node metastasis can be up to 66%, so if the lesion involves the muscularis

Table 76.4 American Joint Committee on Cancer (AJCC) 8th edition, appendix

Stage	features	
Primary tumor (T)		
Tx	Primary tumor cannot be assessed	
T0	No evidence of primary tumor	
T1	Tumor 2 cm or less in greatest dimension	
T2	Tumor more than 2 cm but not more than 4 cm	
T3	Tumor more than 4 cm or with subserosal invasion or involvement of the mesoappendix	
T4	Tumor perforates the peritoneum or directly invades other adjacent organs or structures (excluding direct mural extension to adjacent subserosa of adjacent bowel), e.g., abdominal wall and skeletal muscle	
Regional lymph Nodes (N)		
Nx	Regional lymph nodes cannot be assessed	
N0	No regional lymph node metastasis	
N1	Regional lymph node metastasis	
Distant metastasis (M)		
M0	No distant metastases	
M1	Distant metastasis	
M1a	Metastasis confined to the liver	
M1b	Metastasis in at least one extrahepatic site (e.g., lung, ovary, nonregional lymph node, peritoneum, bone)	
M1c	Both hepatic and extrahepatic metastases	
Stage grouping		
Stage		5 year survival
Stage I	T1, N0, M0	93–100%
Stage II	T2, T3, N0, M0	78–100%
Stage III	T4, N0, M0 Any T, N1, M0	58–78%
Stage IV	Any T, Any N, Any M	22–32%

Table 76.5 Table American Joint Committee on Cancer (AJCC) 8th edition, colon and rectum

Stage	features	
Primary tumor (T)		
Tx	Primary tumor cannot be assessed	
T0	No evidence of primary tumor	
T1[a, b]	Tumor invades lamina propria or submucosa and size 2 cm or less	
T1a	Tumor less than 1 cm in greatest dimension	
T1b	Tumor 1–2 cm in greatest dimension	
T2[a, b]	Tumor invades muscularis propria or size more than 2 cm with invasion of lamina propria or submucosa	
T3[a, b]	Tumor invades through the muscularis propria into the subserosa, without penetration of the overlying serosa	
T4[a, b]	Tumor invades the visceral peritoneum or other organs,	
Regional lymph nodes (N)		
Nx	Regional lymph nodes cannot be assessed	
N0	No regional lymph node metastasis	
N1	Regional lymph node metastasis	
Distant metastasis (M)		
M0	No distant metastases	
M1	Distant metastasis	

Table 76.5 (continued)

Stage	features	
M1a	Metastasis confined to liver	
M1b	Metastasis in at least one extrahepatic site (e.g., lung, ovary, nonregional lymph node, peritoneum, bone)	
M1c	Both hepatic and extrahepatic metastasis	
Stage grouping		
Stage		5 year survival
Stage I	T1, N0, M0	91–97%
Stage IIA	T2, N0, M0	69–84%
Stage IIB	T3, N0, M0	
Stage IIIA	T4, N0, M0	21–65%
Stage IIIB	T1, N1, M0 T2, N1, M0 T3, N1, M0 T4, N1, M0	
Stage IV	Any T, Any N, M1	17–25%

[a]*Note:* For any T, add "(m)" for multiple tumors [TX(#) or TX(m), where X = 1–4 and # = number of primary tumors identified**]; for multiple tumors with different T, use the highest

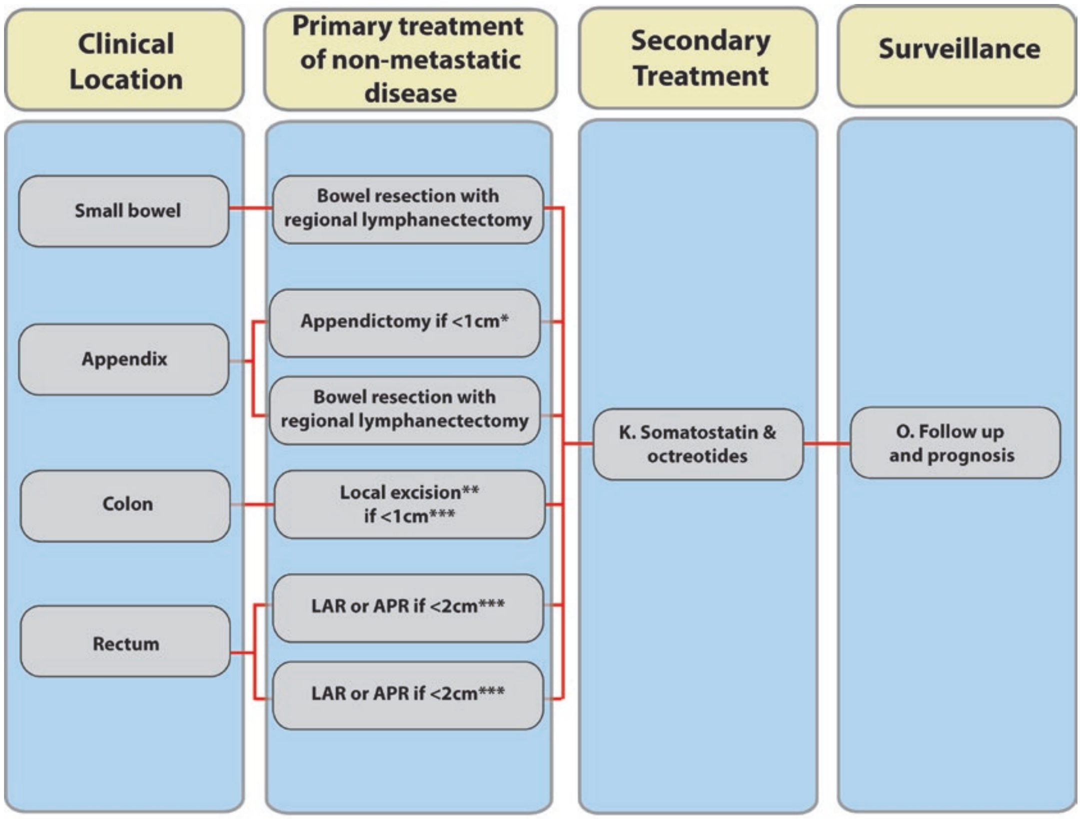
[b]*Example:* If there are two primary tumors, only one of which invades through the muscularis propria into the subserosal tissue without penetration of the overlying serosa, we define the primary tumor as either T3(2) or T3(m)

Table 76.6 Pathological features of carcinoid tumors used in staging and predicting prognosis

Histological classification	Well differentiated (Low grade, G1)	Moderately differentiated (intermediate grade G2)	Poorly differentiated (high grade, G3)
Appearance	Monomorphic population of small, round cells	No well defined	Cellular pleomorphism
Mitotic rate	<2	2–20	>20
Ki-67 index	<3%	3–20%	>20%
Necrosis	Absent	Not well defined	Present
Prognosis	Prolonged survival	Intermediate	poor

propria or is associated with suspicious lymph nodes or lymphovascular invasion, it should be treated with radical oncological resection, whereas lesions without high-risk histologic features can be considered for local excision. For colonic carcinoids, radical oncologic colon resection with regional lymphadenectomy is recommended.

K. The cornerstones of systemic therapy for carcinoids tumors consist of octreotide and somatostatin analogues (SSA). They are used in patients with carcinoid syndrome and for symptom control prior to definitive surgical resection. Octreotide and SSA are also used in asymptomatic patients with disease progression, to treat and prevent carcinoid crisis before, during and after surgical resection and/or liver embolization. Out of five subtypes of somatostatin receptors identified within carcinoid tumors (SSTR 1–5), subtype 2 and 5 are the receptors that mediate most of the beneficial effect of SSA. Activation of these receptors results in reduction in active hormonal synthesis and secretion. SSA has also been shown to be very effective in reducing disease progression in 50–60% of patients with advanced carcinoid tumors. However, its impact on overall survival remains to be proven. Standard dosing of octreotide long acting repeatable (LAR) consist in 20–30 mg intramuscular injection every 4 weeks. However, since therapeutic levels are not achieved for 14 days after the first LAR injection, short acting octreotide (150–250 μg



* Appendiceal carcinoids between 1-2 cm are managed with right hemicolectomy if the base of the appendix is involved, if there is extension to the mesoappenidx or subserosal lymphatics, or if goblet cells are present on pathology. Otherwise, an appendectomy is sufficient.

** Local excision include polypectomy, transanal excision (TAE), or transanal endoscopic surgery (TES).

*** Rectal carcinoids between 1-2 cm with involvement of the muscularis propria, suspicious lymph nodes or lymphovascular invasion, are treated with radical oncological resection.

Fig. 76.2 Algorithm showing management of resectable locoregional disease

three times daily subcutaneously) can be added to achieve rapid relief of symptoms and for breakthrough of symptoms. One of the major side effects of octreotide and SSA is the risk of biliary complications (gallbladder empyema, acute cholecystitis, acute pancreatitis and biliary colic) with a 5-year incidence of 19%. In patients in whom treatment with octreotide or SSA is anticipated postoperatively, concurrent cholecystectomy is recommended.

Refer to Algorithm in Fig. 76.3

L. Management of metastatic carcinoid disease is dependent on whether carcinoid syndrome is present and whether R0 resection can be achieved. If there are no contraindications to surgery and an R0 resection can be achieved, then en-bloc resection of all disease may achieve long-lasting symptomatic relief and prolong survival. If R0 resection is not possible, then cytoreductive debulking surgery should be considered. Tumor debulking involve resection of the primary tumor for palliative alleviation of local and systemic symptoms with or without metastasectomy, most commonly for liver metastases. Liver metastasectomy commonly involve anatomical or non-anatomical hepatic resection. Non-surgical treatment options used in conjunction with hepatic resection for large hepatic metastases, for unresectable liver disease, and for patients who are not surgical candidates include hepatic artery emboliza-

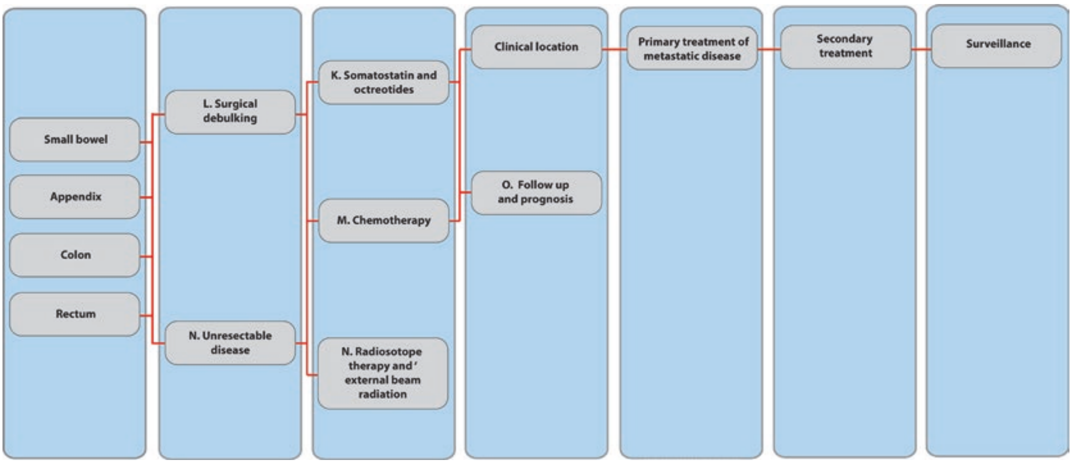


Fig. 76.3 Algorithm showing management of unresectable metastatic disease

tion, hepatic cryoablation, or hepatic radiofrequency ablation (RFA). Hepatic artery embolization is highly effective in debulking liver metastases. The duration of response is usually short ranging from 7 months for hepatic artery embolization alone to 20 months if hepatic artery occlusion was followed by chemotherapy. In Selected patients, embolization can be repeated up to four times every 2–3 months.

M. Chemotherapy has been largely ineffective in the management of advanced unresectable carcinoid tumors. Cisplatin-based chemotherapy has been used in aggressive carcinoids with high proliferative rates. Some studies have shown response rate as high as 67%, but much less in less aggressive indolent tumors. Interferon alpha, has been used in cases refractory to somatostatin and shown to achieve symptomatic relief in over third of cases. It is associated with a median biochemical response rate of 44% (range 0–71%) and a median tumor response rate of 11% (range 0–27%). However, its use is limited by side effects which include anorexia, fatigue, fever and weight loss.

N. Targeted therapy with radiolabeled somatostatin analogues is one of the new developments currently under investigation and used for locally advanced unresectable metastatic carcinoids with positive SRS scan. The peptide receptor radionuclide therapy (PRRT) strategy involves the use of a carrier molecule (octreotide derivate) attached to a variety of different radionuclides including indium-111 (in), 90 Y, and lutetium-177 (177 Lu). The major advantage of PRRT is the ability of these molecules to identify and quantify the target, the somatostatin receptors, before starting treatment. PRRT is well tolerated with low to moderate toxicity. The use of PRRT has been associated with tumor regression in 14–19% of cases with stage IV disease and progression free survival in 4–70% of patients with advanced disease. Finally, external beam radiation is another frequently used option for palliative symptomatic control of bone and central nervous metastasis.

O. With respect to long-term follow-up, in the first year following resection, patients should be monitored every 3–12 months with history and physical exam, CT scans or MRI, serum CgA and urinary 5-HIAA levels. If the baseline SRS scan was positive preoperatively, yearly scans should be performed. Following local excision (endoscopic or transanal excision) of rectal carcinoids for lesion 1–2 cm in size, surveillance endoscopy with rectal MRI should be performed at 6 and 12 months, with subsequent evaluation performed if clinically indicated. For resected rectal lesions <1 cm in size with negative margins and no evidence of high-risk histopathological features, no specific follow-up is recommended. Overall, follow-up should

be continued for up to 10 years post-resection. With respect to prognosis, 5-year survival rate for localized carcinoid disease approaches 100% after complete R0 resection, 45–68% for resectable metastatic disease, and 38–58% for unresectable disease.

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Part VII

Stomas

Stomal Prolapse

77

David J. Hiller and Juan J. Nogueras

Refer to Algorithm in Fig. 77.1

A. Stomal prolapse occurs when full thickness intestine protrudes through a stoma (Fig. 77.2). Prolapse can be seen with ileostomies, colostomies, and urostomies. The incidence of prolapse ranges from 1% to 42%.

B. The effect on patients can range from asymptomatic to obstruction and strangulation. Symptomatic prolapse does not always require emergent operative intervention as when it causes strangulation and necrosis (Fig. 77.3). Symptoms can include weeping, mucosal irritation, and bleeding. Prolapse can also have indirect consequences. Prolapse can cause appliances to fit poorly or dislodge more easily. This can lead to skin irritation, bleeding, ulceration (Fig. 77.4), and increased frequency of appliance changes.

C. Risk factors for prolapse include age, obesity, increased intra-abdominal pressure (including bowel obstruction), pregnancy, oversized apertures, location lateral to rectus muscle, and presence of a loop stoma.

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D. Loop stomas are more likely to prolapse. The distal end of the loop more commonly prolapses (Fig. 77.5), likely due to the atrophy of the distal limb causing the fascial opening to become wider relative to the bowel and allow for prolapse.

E. Parastomal hernias are more common with colostomies compared to ileostomies and can be present in up to 50% of colostomy prolapse patients. Parastomal hernias are possible with loop and end ileostomies, but less likely.

F. The best method to prevent prolapse is to create the stoma within the rectus abdominis muscle on the abdominal wall. The abdominal wall aperture should not be too large. Traditionally, the "two finger" approach has guided surgeons to determine an adequate size for the aperture. Measurement varies based on the surgeon's hand and the size of the bowel. Creation of a stoma in an emergent obstructive setting can increase the risk of prolapse to 38%. This scenario is more likely to occur when the edema subsides and the bowel no longer requires the size of the aperture created at the time of surgery. Trephine stomas can lead to prolapse for a similar reason; the aperture created for the stoma can be larger than necessary. Studies have suggested a reduction in prolapse with fixation of the mesentery at the internal opening in the abdominal wall, but this is debatable. Suggestions for seromuscular sutures tacking the stoma to the fascia are of dubious benefit

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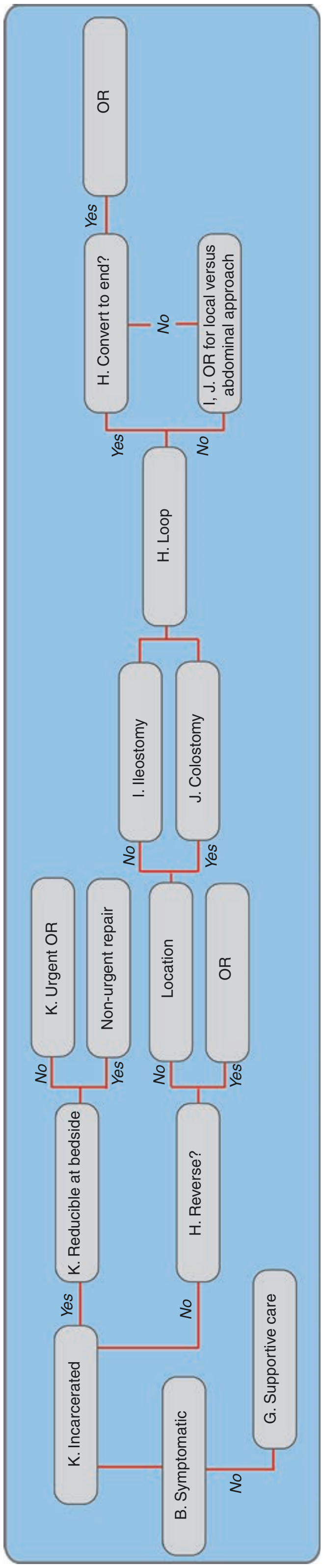

Fig. 77.1 Algorithm for stomal prolapse

Fig. 77.2 Full thickness stomal prolapse

Fig. 77.3 Necrotic prolapsed stoma

Fig. 77.4 Ulceration on prolapsed stoma

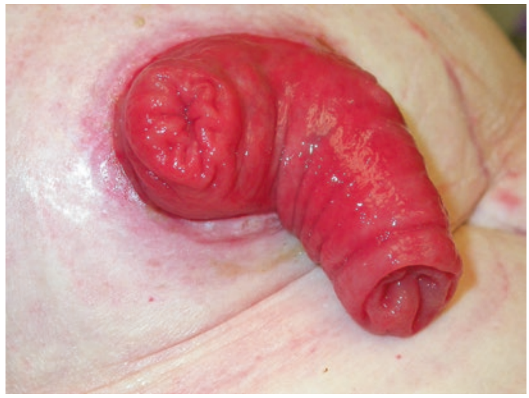

Fig. 77.5 Loop stomal prolapse

and may potentially increase the risk of enterocutaneous fistula formation. Laparoscopic-created stomas have shown low rates of prolapse in small studies.

G. Management for prolapse can be conservative or surgical. Conservative management includes as-needed manual reduction of prolapse and external fixation devices to restrict intestinal movement. Identification of causes of increased intra-abdominal pressure should be identified and treated. Reduction should only require soft pressure to the stoma with the inner-most portion reducing first. If congestion prevents reduction at the bedside, sugar can be applied to the stomal mucosa. The osmotic gradient created will cause a fluid shift that reduces edema.

H. Surgical management can be local or intra-abdominal. The initial step in surgical evaluation is to determine if the stoma can be reversed. If not, then the algorithm includes the evaluation of a loop stoma for potential conversion to an end stoma. The next step is to determine if a local approach will be adequate for repair.

I. For ileostomies, local options include stapling of the prolapsed bowel or mobilization and resection of bowel. Stapling techniques exist for local excision of prolapse without further dissection of the stoma. If the mucocutaneous junction needs to be freed for repair, excise as little skin as possible and dissect free the redundant bowel. Once the bowel

is completely free, the redundant portion can be resected and a new mucocutaneous junction created. Care must be taken not to increase the fascial defect with the revision. Laparotomy, revision, and relocation are options for patients with large parastomal defects or cases where local repair is unsuccessful.

J. Similar surgical approaches can be used for prolapsed colostomies. One option for loop colostomies with distal end prolapse is to convert the stoma to an end colostomy and either convert the distal end to a long Hartmann's pouch or a mucous fistula by dividing the septum between the two ends. The proximal end can be refashioned at the mucocutaneous junction while the distal end can be either placed intra-abdominally for a Hartmann's pouch or secured on the abdominal wall as a mucous fistula. For end colostomies with prolapse, the mucocutaneous junction can be excised and the colostomy freed from the abdominal wall. Resection and re-approximation to the abdominal wall can then occur. Another local approach option is to perform a modified Delorme procedure by performing a mucosal resection and recreating the stoma with the remaining seromuscular layer. Local approaches are the preferred approach for repair, but unfortunately are not always possible and require either laparoscopic assistance or a laparotomy for revision. Parastomal hernias with colostomies that need repair can be approached in this manner and are addressed in the parastomal hernia chapter.

K. Incarceration will force immediate action. Initially, reduction at bedside should be attempted and can be aided by covering the mucosa with table sugar as is done in rectal prolapse. This measure will allow improvement in edema and increase the chance to reduce the incarcerated prolapse, allowing for an elective repair rather than an emergent operation. If the prolapse cannot be reduced, a local approach should be considered as this would allow for repair without the risk of intra-abdominal contamination. If this approach is unsuccessful or if there is concern for threatened bowel proximal to the stoma, then the surgeon should prepare for laparoscopy and/or laparotomy.

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78 Stomas: Parastomal Hernias

David E. Beck

Refer to Algorithm in Fig. 78.1

A. Parastomal hernia is one of the more common late complications of an ostomy. Paracolostomy hernias are more frequent than are paraileostomy hernias and incidence varies with the indication for the stoma and the length of follow up. The reported rates have varied from 4% to 48% for colostomies and 1.8% to 28% for ileostomies. Additional predisposing factors include obesity and emergency surgery.

B. Symptoms will vary from an asymptomatic parastomal bulge to a large abdominal wall protuberance that is cosmetically unsightly. Patients may have trouble keeping the appliance attached and there is the potential for small bowel incarceration and obstruction. Peritoneal stretching may produce mild discomfort, however severe pain or tenderness may mimic bowel ischemia. Of particular importance is whether the patient's ostomy is correctly sighted and constructed. A stoma that is in a poor location (in a skin crease, near a bony prominence or scar) may benefit more from relocation rather than repair. Examination will reveal a bulge at the stoma site. With the patient supine and relaxed it will often be reducible. Digital examination through the stoma may give a better appreciation of the bulge and fascial defect with Valsalva.

C. In obese patients, it may be difficult to confirm the present of a parastomal hernia. While ultrasound has been described, the best radiological examination is a CT scan. An abdominal CT scan accurately identifies the presence of a hernia, size of the defect, and can document the presence of small or large bowel in the defect (Fig. 78.2). In addition, the size of the proximal bowel can give an indication regarding obstruction

D. Laboratory studies are only useful to assist in evaluation operative or anesthetic risks. These should be dictated by the operative risk alone. In emergent situations of incarcerated bowel, the white blood cell may be elevated.

E. Endoscopy is only used in patients with a history of inflammatory bowel disease to exclude active disease. In addition, prior to repair, if the patient requires endoscopic evaluation for colorectal cancer screening/surveillance guidelines, this should be performed.

F. If surgical therapy is contemplated, the patient should be assessed for operative risks. This evaluation may involve appropriate consultation for cardiac, pulmonary or generalized medical evaluation and prehabilitation. In general, these are elective repairs, and

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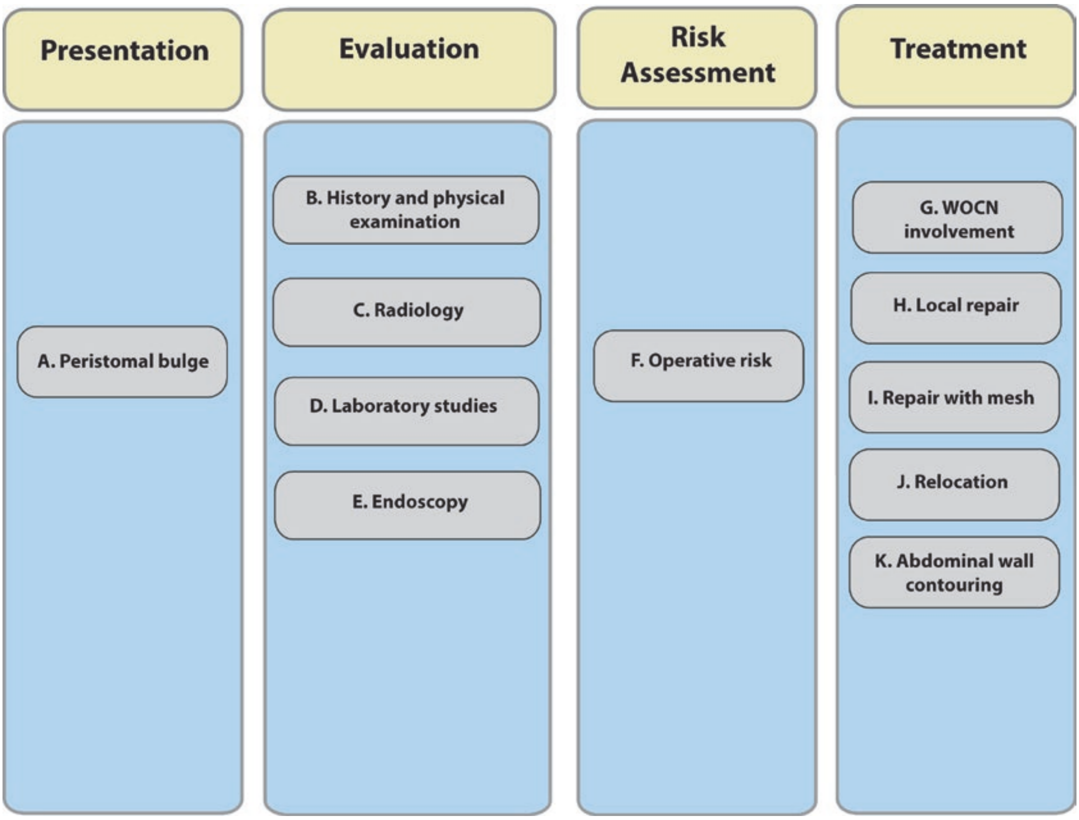


Fig. 78.1 Algorithm for parastomal hernias. *WOCN* wound ostomy care nurse

Fig. 78.2 Abdominal CT scan demonstrating parastomal hernia

consideration should be given to weight loss, blood pressure and diabetic optimization, as well as smoking cessation.

G. Asymptomatic patients do not require repair, but may benefit from interaction with a Wound ostomy care nurse (WOCN). Ostomy care and techniques such as use of a support belt or convex appliance can often alleviate mild or moderate symptoms. WOCN should also evaluate patients prior to surgery for evaluation and marking should stomal relocation be required.

If surgical repair is indicated, a number of surgical options are available.

H. A local repair is less complicated, however in the absence of reinforcement with mesh, this method has a large recurrence rate (33–50%). In part this is due to all the patient factors that led to the initial hernia remain present. The technique involves suture closure of the fascial defect either intra-abdominally (usually through a midline incision) or anteriorly via a circumferential stomal incision.

I. To improve the results of local repair mesh has been used as an adjuvant. Both synthetic and biologic meshes have been used. The size of the mesh appears important, and most authors recommend an overlap of at least 5 cm. Mesh has been placed in several locations: intraabdominal (preperitoneal or sublay), inlay (between or in place of the fascial planes), and onlay (extraperitoneal) (Fig. 78.3). The mesh can be used with a "key hole" technique or in a manner described by Sugarbaker. Both types of repair have been described using open and laparoscopic approaches.

With an open approach, the patient is usually explored from the midline although in very large hernias an elliptical incision at or below the stoma may be used. Once the abdomen is entered, adhesions to the previous incisions and those in the hernia sac are divided. The hernia sac is usually removed, but whether this is necessary remains unproven. From the midline, the stomal fascial defect is closed with permanent sutures (e.g. #2 polypropylene). Fascial reinforcement in the underlay position can be accomplished with two techniques.

With a keyhole technique, a mesh size is selected that will extend 5-cm beyond the edge of the closed hernia. A cruciate hole, the size of the bowel, is created in the center of the mesh and a slit is created from the medial side of the mesh to the central defect (Fig. 78.4). A critical part of this technique is to not make the keyhole too small to cause a bowel obstruction, but to not make it so large as to increase the risk of reherniation. The cut mesh is then maneuvered around the bowel and sutured in place with polypropylene sutures. The slit is closed with sutures and sutures are placed at the corners and the middle edge of the mesh. Abdominal pressure holds the mesh against the abdominal wall during the healing process.

The Sugarbaker method requires that the bowel have adequate laxity to allow the bowel

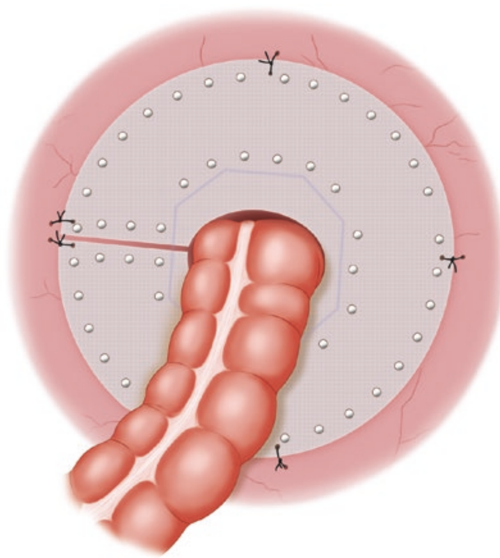
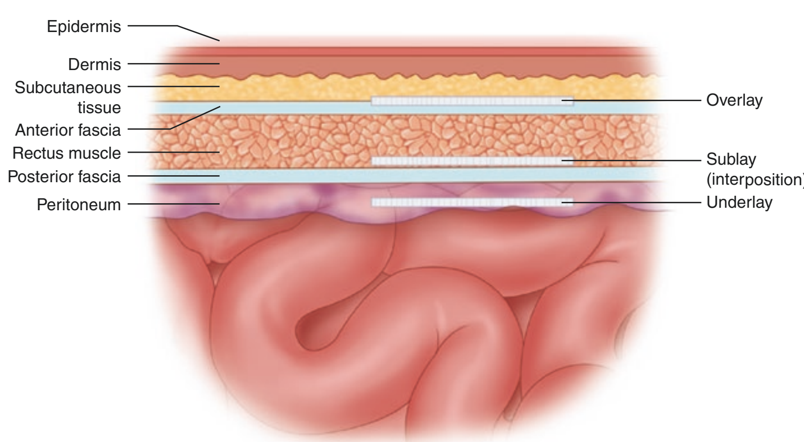


Fig. 78.4 Keyhole mesh

Fig. 78.3 Mesh placement



to track between the mesh and abdominal wall. Reduction of the hernia will usually provide adequate laxity. If that doesn't, additional mobilization of the bowel may be necessary to allow adequate lateralization of the bowel. The ostomy bowel is carefully delivered into the abdomen to reduce any prolapse. The ostomy bowel is then retracted to the lateral or superior edge of the hernia defect. Some surgeons will then suture the ostomy bowel serosa to the peritoneum with absorbable sutures at the edge of the defect. The abdominal wall is also inspected for additional hernias which need repair. A piece of mesh that will cover the hernia defect with a 5-cm overlap is selected. Both synthetic and biologic meshes have been described. Synthetic mesh is less expensive and easier to fix to the fascia. The mesh is fixated at the edges, close to the bowel and medially with sutures or tacks.

The sandwich technique is a combination of both the keyhole and Sugarbaker techniques, using a piece of mesh in the intraperitoneal position as in the keyhole technique and then lateralizing the bowel and covering this with another piece of mesh using the Sugarbaker technique. This technique does result in an area of mesh overlapping with mesh.

The procedure can also be performed with laparoscopic techniques. Initially, a 10/11 mm balloon trocar is placed using an open (modified Hasson) technique in the lateral abdomen on the side opposite the ostomy and hernia. Laparoscopic inspection of the peritoneal cavity rules out unsuspected pathology and identifies the patient with dense extensive adhesions that would make a laparoscopic approach problematic. Additional ports are placed and adhesions to the anterior abdominal wall are divided with sharp dissection and traction. This can often be tedious and has the potential for bowel injury. This is especially true if previous repairs have used mesh. Extensive dense adhesions may require conversion to an open technique. Bowel loops are gently reduced from the hernia using traction and carful division of adhesions. Alternate energy sources may be helpful for some vascular adhesions, but are not a substitute for careful dissection. When all the bowel has been reduced, the bowel leading to the stoma will remain. The peritoneal sac is left in place. Both keyhole and Sugarbaker methods have been described with laparoscopic techniques, but the Sugarbaker method is technically easier laparoscopically. The technique requires that the bowel have adequate laxity to allow the bowel to track between the mesh and abdominal wall. Reduction of the hernia will usually provide adequate laxity. If that doesn't, additional mobilization of the bowel may be necessary to allow adequate lateralization of the bowel. The ostomy bowel is pulled intraabdominally, to reduce any prolapse. The ostomy bowel is then pulled to the lateral or superior edge of the hernia defect. Some surgeons will then suture the ostomy bowel serosa to the peritoneum with absorbable sutures at the edge of the defect. The abdominal wall is also inspected for additional hernias which need repair. In addition, a modified Sugarbaker technique has been described where a local primary repair of the fascial defect is added via a peri-stomal curvilinear incision.

A piece of mesh is selected that will cover the hernia defect with a 5-cm overlap. It is often helpful to compare the mesh on the abdominal wall, however to minimize the risk of contamination, the mesh should not touch the stoma itself and contact with the skin should be avoided. Several types of mesh have been used, including non-absorbable, absorbable, partly absorbable, and acellular collagen matrix meshes. Early authors used a polypropylene mesh. Subsequently, composite meshes were used and more recently some authors have expressed a preference for biologic meshes.

Two peripheral tacking sutures (0 polydioxanone), 4–5 cm apart, are placed at the edge of the mesh where the stoma will pass. The mesh is then tightly rolled and inserted through incision for the Hasson trocar. The mesh is unrolled and moved toward the

stoma and hernia and oriented. After orientating the mesh the traction sutures are extracted with a "suture passer" technique through small separate skin incisions 4–5 cm apart, located one cephalad, the other caudal to the stoma, and 4–5 cm lateral to the hernia defect. The mesh is anchored to the abdominal wall by tying these sutures creating transabdominal fixation. Inspection should be carried out to ensure that the stoma is not obstructed where it passes between these two sutures (Fig. 78.5a). Further fixation of the mesh is done with a mechanical fixation device (e.g. SorbaFix™ or ProTack™) at the margin of the mesh and along the bowel tract and edge of the fascial defect (Fig. 78.5). Care is taken to produce appropriate tension on the mesh and to avoid putting the tackers into the ostomy bowel or mesentery and to allow enough laxity for the ostomy bowel to exit the mesh (Fig. 78.5c). As tacking devices have improved the number of traction/fixation sutures has been reduced or eliminated. The authors currently use transfascial fixation sutures (0-polydioxanone) every 4–5 cm around the edges of the mesh. After mesh fixation, the bowel is again expected to exclude any unsuspected injury or bowel compression.

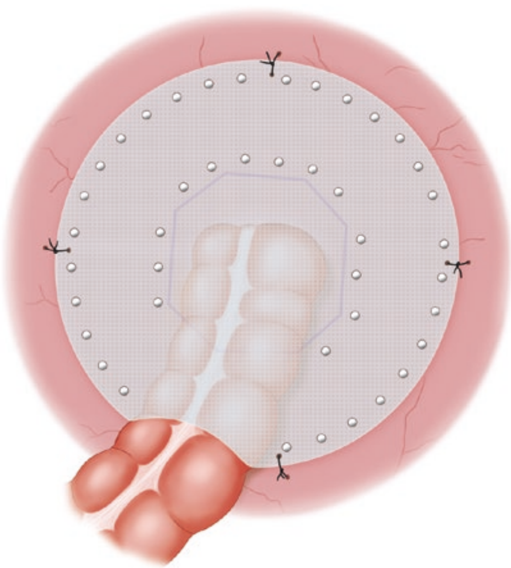


Fig. 78.5 Sugarbaker repair with mesh

J. Relocation is preferred if the stoma is in a poor location. A new stoma site should be selected on the contralateral side or an upper abdominal location. Translocation is a technique in which the ostomy is moved without a formal laparotomy. The technique starts with mobilizing the ostomy with a peristomal curvilinear stomal incision down to the fascia (Fig. 78.6a). Additional intra-abdominal adhesions are divided to allow adequate bowel mobility to reach the new site without tension. The end of the bowel is temporarily closed with clamps. The abdominal wall is elevated with a retractor and an intra-abdominal path is created by dissection adhesions off the posterior abdominal wall until the new stoma site, which was selected preoperatively, is reached. The abdominal wall is elevated by the surgeon's intra-abdominal fingers and a new ostomy opening is created (Fig. 78.6b). A clamp is placed through the new stoma opening and the end of the bowel is grasped and maneuvered to and out the new opening (Fig. 78.6c). The stoma is matured. The old ostomy site is then closed.

K. Abdominal wall contouring (*i.e.,* modified abdominoplasty) is a technique that uses modified plastic surgery techniques to reconstruct the abdominal wall to reconstruct an improved ostomy. A low curvilinear transverse incision is made at the inferior abdominal fold or 2–3 cm above the pubis and anterior superior iliac spines (Fig. 78.7a) and carried down to the fascia. A flap of skin and subcutaneous tissue is created by electrocautery dissection in a cranial direction, just above the fascia. Perforating vessels are identified and ligated or cauterized. As the dissection continues, the stoma will be encountered. With the flap on traction, the intestine is separated from the skin and subcutaneous tissue. Care is taken to avoid injury to the bowel or its blood supply. The dissection should err on leaving additional subcutaneous fat attached to the intestine. This can be carefully resected later. A similar maneuver may be performed at the

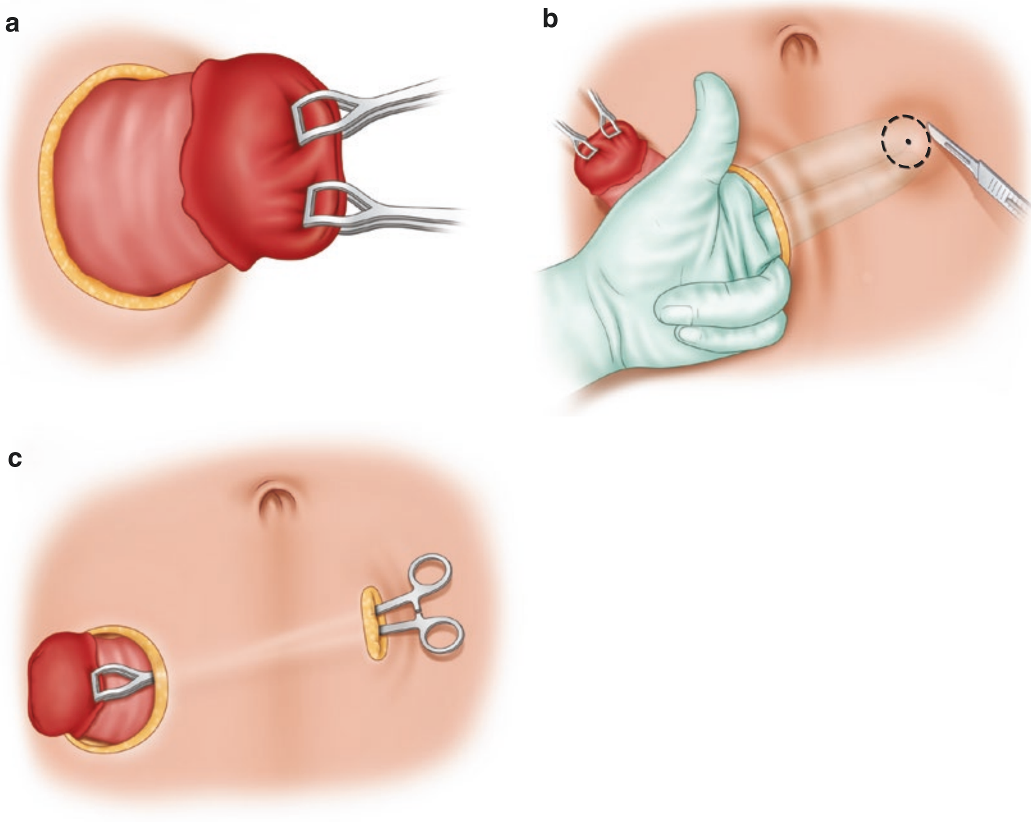


Fig. 78.6 Translocation technique for stomal relocation

umbilicus if the surgeon and patient prefer to preserve it in its normal location. Again, care is taken to preserve the tissue's blood supply. If the umbilicus is not to be maintained, it can be amputated at the fascial level. The flap dissection is continued cranially just above the fascia until enough laxity or length is obtained in the upper flap for the upper edge of the previous stomal opening to reach the inferior portion of the incision without excessive tension or to the costal margins. Any associated peristomal hernia can be repaired at this time with suture repair of the fascia and/or mesh (*e.g.*, synthetic or biologic) reinforcement.

As the flap is retracted inferiorly, new sites for the ostomy and, if desired, the umbilicus are selected and openings created in the flap. Excess subcutaneous fat can be carefully removed to thin the flap. Fortunately, there is usually less subcutaneous fat above the umbilicus compared with below it. The excess, distal portion of the flap is excised (Fig. 78.7b). The intestine and umbilicus are brought through the respective flap openings and matured with interrupted absorbable sutures (Fig. 78.7c). Excess bowel or umbilical tissue can be carefully excised. Closed suction drains are placed below the flap to avoid seromas and the inferior incision is closed in layers.

As intra-abdominal dissections are avoided with this technique, patients usually recover quickly. Morbidity is usually associated with infection, flap ischemia, or seromas. These are managed with wound care.

Several types of flaps can be used to modify the abdominal wall around the stomas. Most involve peristomal dissections and removal of skin and subcutaneous fat. The medial approach starts with an incision through the midline incision down to the

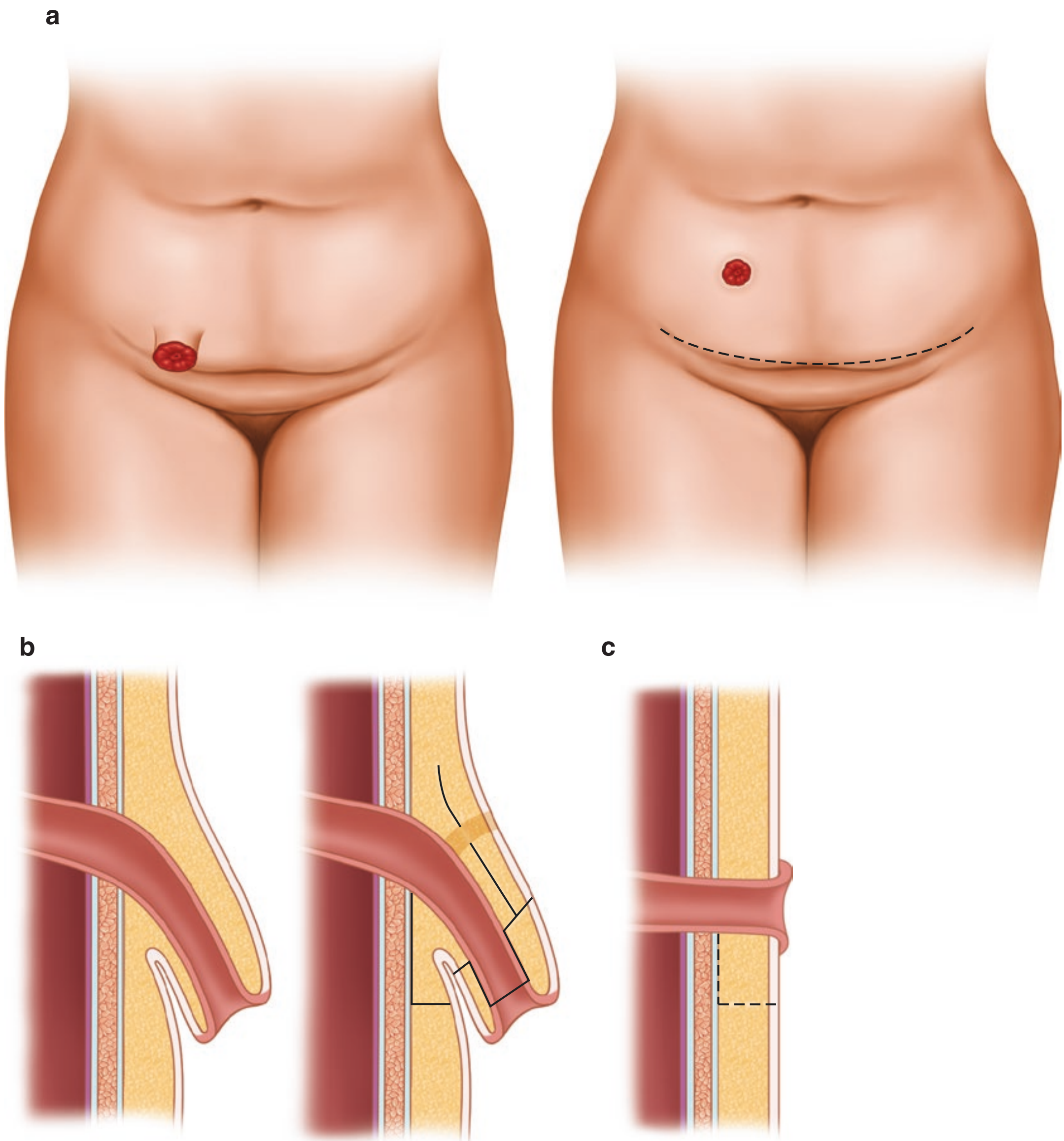


Fig. 78.7 Abdominal wall contouring

fascia. Dissection is carried laterally just above the fascia until the stoma is reached. The ostomy is dissected free of the skin and subcutaneous tissue as described above. After the stoma is freed, lateral dissection to the flanks will provide enough laxity to advance the previous stoma site to the midline (advancement flap). As above, a new ostomy opening, in fresh skin, is created. Excess fat may be excised around the stoma and redundant midline skin is resected.

If the skin flap is not redundant enough to advance the original ostomy opening to the midline, the subcutaneous fat can be excised and the stoma returned to its original skin opening through the thinned flap. Either method is performed in such a manner to leave a smooth, flat, thinned flap that provides a flat surface to site the appliance. The stoma is matured and the midline incision is closed. Subcutaneous closed suction drains are placed above and below the stoma.

A similar technique can be used through an inferior or inferolateral peristomal incision. A curvilinear incision is made below or lateral to the ostomy outside the location of the face plate. The size and direction of the incision are determined taking into consideration the blood supply of the peristomal skin. The subcutaneous tissue is dissected off the fascia with electrocautery in a manner like the technique used for a peristomal hernia repair. After this dissection is completed, excess subcutaneous fat can be excised in a circumferential manner. Care is taken to remove the fat in a way to avoid a lumpy peristomal area. Small closed suction drains are placed and the incision is closed. If the thinned flap appears redundant after the subcutaneous tissue is removed, the stoma can be separated from the flap and the flap can be advanced toward the incision in a manner described previously. The bowel can be re-sited through the advanced flap and the excess flap excised.

The circumstomal approach starts with an incision around the stoma at the mucocutaneous junction. With careful dissection, the bowel is separated from the subcutaneous tissue down to the fascia. The subcutaneous tissue is then separated from the fascia with electrocautery in a circumferential manner to a point 7–8 cm out from the stoma. A wedge of subcutaneous tissue is circumferentially created from the upper skin edge to meet the outer edge of the extrafascial dissection (Fig. 78.8a). Small, closed suction drains may be placed and the ostomy is matured to the skin edges (Fig. 78.8b). If there was a preoperative stenosis, the skin opening may be enlarged or the bowel may be matured with a Z-plasty technique (Fig. 78.9). If the preoperative stomal opening was too large or it becomes too large from the dissection, the diameter of the opening can be reduced with interrupted sutures (Fig. 78.10). This type of closure has been referred to as the "Mercedes technique."

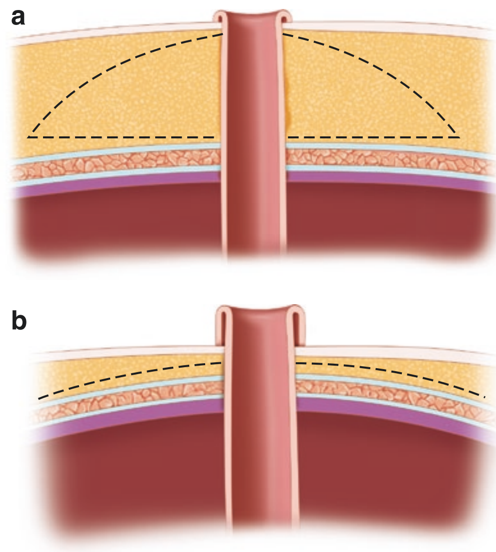


Fig. 78.8 Circumstomal approach

Postoperative Management

The orogastric tube is removed prior to extubation and the bladder catheter is removed later in the day or the next morning. Patients are supported with intravenous fluids and offered liquids when they are hungry. Solid food is started when flatus is expressed from the stoma. Pain management is usually provided by patient controlled analgesia supplemented with ketorolac. The patient is switched to oral pain medication when they are taking fluids and early ambulation is encouraged. Patients are ready for discharge when they can care for their stoma, tolerating a diet and have evidence of bowel function. As the bowel is not detached from its skin attachment, and stomal education is not required, recovery is usually rapid.

Complications

Early complications include unsuspected bowel injury, infection, or obstruction of the colon. Longer term complications include hernia recurrence, bowel erosion, and rarely pain.

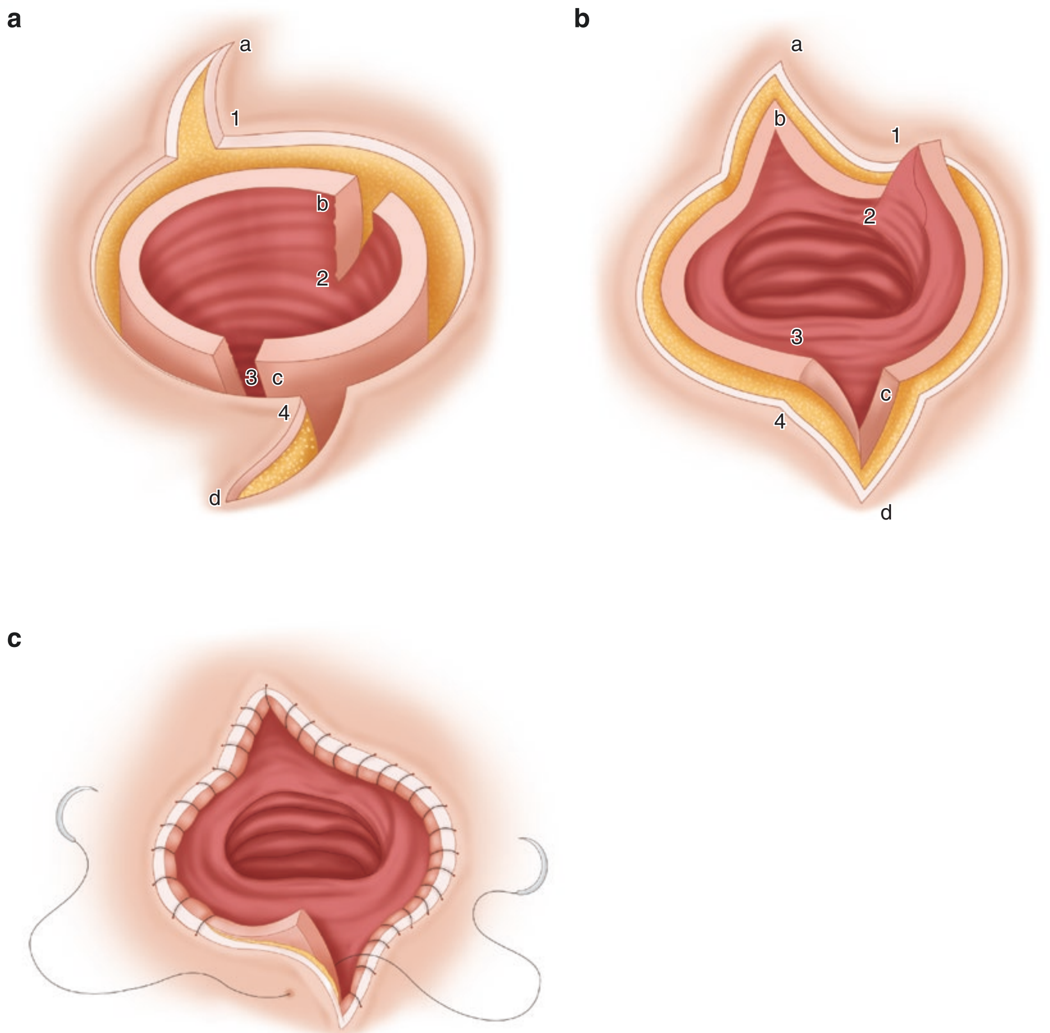


Fig. 78.9 Z-plasty technique

Results

A number of small laparoscopic series with short follow-up and systemic reviews have been published. Pooling four non-randomized studies resulted in 7 recurrences out of 72 repairs. A laparoscopic technique is not feasible in all patients, and in one study 15% of 55 patients had to be converted to an open procedure. In two studies of 59 patients, bowel injury occurred in 22% of patients. In a study of 47 patients in which ePTFE mesh was used 9% had to have the mesh removed due to infection.

A systematic review in 2011 of four retrospective studies, included 57 patients in which biologic mesh was used to repair peristomal hernias. The studies used a variety of techniques for mesh placement with open and laparoscopic techniques. The recurrence rate was 15.7% and the wound related complication rate was 26.2%. No

a
b
c

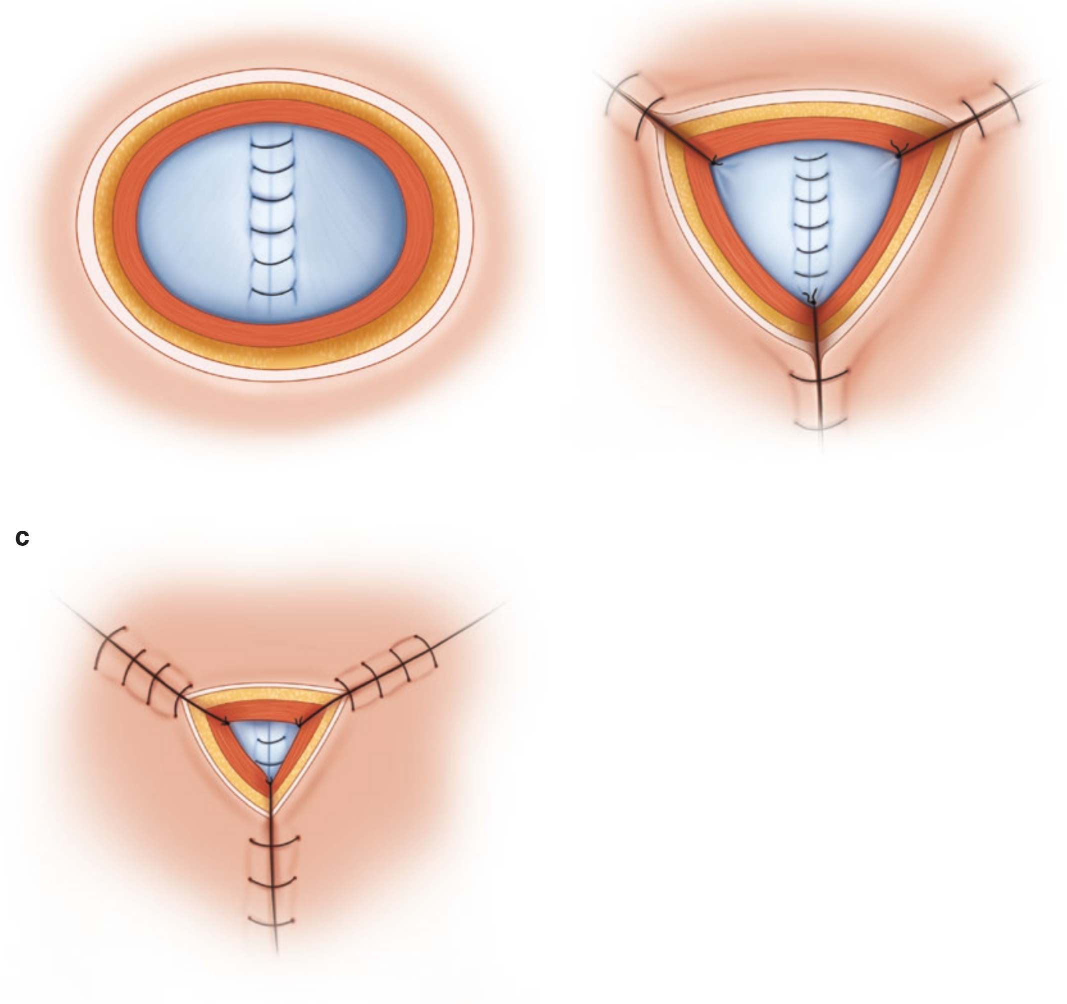


Fig. 78.10 "Mercedes closure" of stoma site

mortality or graft infections were reported. The authors concluded that the results were like results following the placement of synthetic mesh.

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Stoma Retraction and Stenosis

79

James Tankel and Yair Edden

Defining the Problem: Retraction

A. A strict definition of a retracted stoma is one that lies 0.5 cm or more below the skin surface, occurring within 6 weeks of stoma formation and requiring surgical intervention. However, more broadly retraction refers to any stoma on which traction of the underlying bowel results in the stoma being pulled back into the abdominal cavity (see Fig. 79.1). It is a relatively common problem being reported to occur in up to 14% of colostomies and 12% of ileostomies within 3 weeks of surgery. Retraction can occur at any point postoperatively although is less common as time passes. To some extent, whether or not retraction will occur can also be predicted. If either a colostomy or ileostomy that is less than 10 mm in height within the first 2 days post-operatively, there is a 35% of retraction becoming clinically significant.

B. The root cause of stomal retraction is usually tension on the stoma by the underlying bowel. Patient anatomy such as short mesentery or thick abdominal wall can make exteriorization of the bowel more difficult. Similarly, postoperative weight gain alters distance between the fascia and skin and may also result in relative retraction. Other recognized causes of retraction include progression of inflammatory bowel disease or recurrence of malignancy. Surgical factors such as stomal ischemia and necrosis, mucocutaneous separation, early rod removal in loop stoma formation, improper stoma placement and importantly failure to adequately mobilize the bowel can also lead to retraction.

Fig. 79.1 Retraction refers to any stoma on which traction of the underlying bowel results in the stoma being pulled back into the abdominal cavity

C. The impact of stomal retraction is improper device fixation that can lead to fecal leakage and skin irritation, which can have a substantial impact on patient quality of life. Retraction in the presence of a loop stoma

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may result in incomplete fecal diversion. Early retraction may also cause mucocutaneous dehiscence resulting in intra-abdominal contamination.

Defining the Problem: Stomal Stenosis

D. Stomal stenosis can be defined as narrowing of the lumen at either the cutaneous or fascial level. As with retraction, it is a relatively common early problem with an incidence of anywhere between 2% and 15% being recorded in the first 5 years after stoma formation. It can however occur at any point in the post-operative period.

E. The causes of stenosis are broad but can be categorized easily. The progression of underlying pathology including inflammatory bowel disease or carcinoma is a well-recognized cause. Surgical factors including poor operative technique leading to ischemia with or without necrosis, post-operative infection, or an inadvertently small abdominal wall opening may also contribute.

F. The symptoms of stenosis include noisy passage of flatus or pain on defecation however such significant stenosis causing obstruction is rare. Episodes of constipation can occur interspaced with diarrhea as liquid stool passes the occlusion.

Refer to Algorithm in Fig. 79.2A Avoiding Retraction

G. Preoperative marking of the intended stoma site is essential especially in obese patients. Placement of the stoma superior to the umbi-

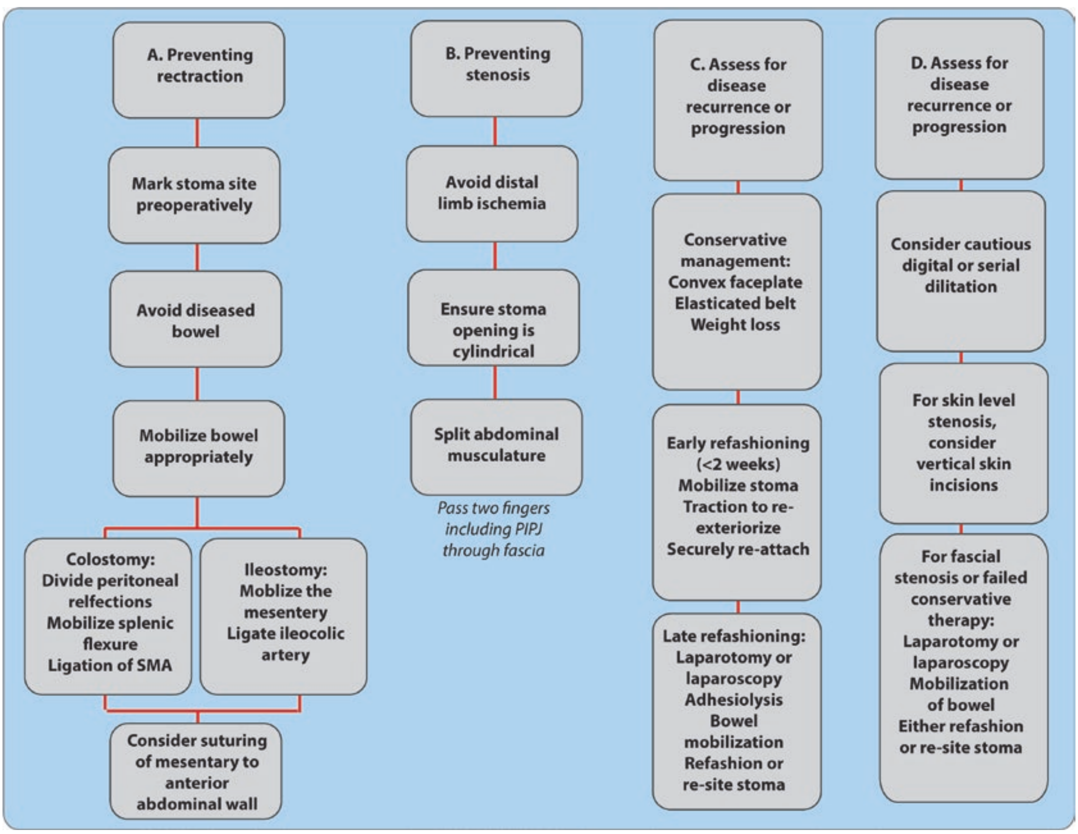

Fig. 79.2 Algorithm. (A) Preventing stomal retraction. (B) Preventing stomal stenosis. (C) Management of a retracted stoma. (D) Management of a stenosed stoma

licus often results in passage through less fat than those stomas placed inferior.

H. During the initial operation, as bowel that is affected either by inflammatory bowel disease or carcinoma is prone to retraction, bowel that is clearly diseased or edematous should be avoided. Several options also exist to help avoid retraction from occurring by increasing mobility of the bowel. For colostomies of the descending colon, division of the lateral and medial aspects of the peritoneal reflections allow a degree of mobilization of the colon. If this is insufficient, mobilization of the splenic flexure and then ligation of the root of the inferior mesenteric artery (IMA) provide more length. Although this allows complete mobilization of the left side of the colon it leaves the descending colon dependent on the collateral blood supply of the superior mesenteric artery. If mobilization is still insufficient 'windows' can be made in the mesentery of the transverse colon. If despite all these steps the descending colon is still under tension, then either the formation of a loop ileostomy or 'pseudo-loop colostomy' from bowel that is proximal to the closed limb of bowel should be considered.

I. Often little additional mobilization is required to fashion an ileostomy. If however tension exists, mobilization of the mesentery of the small bowel can make a significant difference. The ileocolic artery can also be ligated at its origin.

J. To ensure sufficient mobilization of an ileostomy/colostomy one must look and feel the limb of bowel from which the stoma will be formed to see if either the bowel or the mesentery is under tension. The stoma should be closely evaluated prior to the abdominal closure, in case additional adjustment of the bowel is indicated.

K. To help avoid retraction once the bowel has been sufficiently mobilized, the mesentery of the bowel or the serosa itself can be sutured to the posterior aspect of the anterior abdominal wall with interrupted absorbable sutures. Controversy exists surrounding the exact benefit of this step although it probably does reduce the incidence of stomal prolapse.

L. During the weeks after surgery an ostomy may shrink to 2/3 of its original postoperative size. For an ileostomy, due to its liquid content, 4–6 cm of skeletonized bowel should still sit beyond the skin of the abdominal wall. This is because once everted, the ideal ileostomy length should be 2–2.5 cm. For a colostomy, only 1–2 cm of large bowel needs to be exteriorized.

Refer to Algorithm in Fig. 79.2B Avoiding Stenosis

M. In order to avoid stricture some simple methods can be employed during the initial operation. Generally speaking, as stenosis is often caused by ischemia, choosing bowel that with a good blood supply is of utmost importance. Checking for bleeding at the cut end of the bowel before stoma formation is a reliable option. Also a maximum of 6 cm of bowel should be skeletonized as more than this can result in ischemia of the distal end of the bowel limb.

N. For ileostomies, a 3–4 cm diameter cylinder of skin and underlying fat should be excised down to the fascia. Ideally, a longitudinal incision is made through the anterior aspect of the rectus fascia, with longitudinal splitting rather than cutting of the abdominal musculature encountered. Finally another horizontal incision through the posterior rectus fascia should be made. Some surgeons opt for a cruciate incision through the abdominal musculature and fascia. Either a diathermy or knife can be used however the width of the dissection through the abdominal wall should be the same as the diameter of the cylinder of skin and fat removed. To ensure the opening is wide enough, two fingers—including the proximal interphalangeal joint—should be passed through the opening. As noted, the bowel should ideally pass through the rectus sheath.

O. For colostomies, a similar approach is made to open the abdominal wall. Again, at-least two fingers—including the proximal interphalangeal joint—should be passed through the abdominal wall. It is hoped that by checking the diameter, stricture will be prevented by ensuring the opening is wide enough. It should be noted that if the bowel is dilated or the mesentery inflamed, then a larger opening may be required.

Refer to Algorithm in Fig. 79.2C Management of the Retracted Ileostomy

P. (Refer to algorithm in Fig. 79.2C) Foremost, consideration should be given as to whether retraction is secondary to disease progression or recurrence. Hence, the first step in the management of retraction of either ileostomy or colostomy is to consider some form of imaging to assess the bowel for disease. If retraction has occurred, the first step would be to attempt conservative management. This would include the usage of convex stoma faceplate, tight elasticated belts and, if appropriate, weight loss. Often these techniques can overcome troublesome stomal retraction and highlight the importance of the ostomy nurse in post-operative care.

Q. If conservative management fails, surgical refashioning of the stoma may be needed. If retraction occurs in the early postoperative, local refashioning can be attempted. After the sutures holding the stoma have been cut, Allis forceps can be used to grab the internal aspect of the retracted ileostomy and pull it through the abdominal wall. Several options exist to then re-anchor the stoma in position. For instance once the stoma is re-exteriorized from the abdomen stabilizing sutures to be placed between the serosa of the everted bowel and the layers of the abdominal wall essentially creating a new Brooke ileostomy. Alternatives include either full thickness sutures through the inner and outer bowel layers or stapling devices placed perpendicular to the skin. Early success rates are reported at 65% and as this technique can be done under light sedation and hence safe in medically complex patients, it is a viable option in those patients for whom laparotomy is contraindicated.

R. If more than 2 weeks has elapsed since the initial formation of the ileostomy after sharp dissection between the abdominal wall and the serosa of the bowel wall adhesiolysis via the stomal wound can be attempted but may be difficult. Vertical incisions above and below the stoma site can improve exposure, although subsequent scaring may make the ileostomy difficult to manage or encourage stricture formation. Placing the stoma device over the new wound may also be painful. Hence a formal laparotomy is usually required. Eversion and fixation can then be performed in the usual manner however additional sutures between the serosa of the bowel and abdominal fascia can be used to anchor the stoma more firmly in position. As 3 cm is the ideal length of an ileostomy, the surgeon should once again try to mobilize 6 cm of bowel from the outer aspect of the abdominal wall.

Refer to Algorithm in Fig. 79.2C Management of the Retracted Colostomy

S. Refer to algorithm in Fig. 79.2C. A retracted colostomy can be managed either conservatively or surgically. Conservative management is similar to that for ileostomy as noted above. Surgical intervention can be split between local and non-local procedures. Locally, sharp division of the mucocutaneous border with attempted mobilization of the stoma via the opening in the abdominal wall with reattachment of the limb of bowel to the abdominal wall may be successful. As noted above, incisions made to the stoma opening in the abdominal wall in order to increase the size of the opening to gain improved access to abdominal cavity is not recommended as it will not only make the attachment of stoma

devices difficult but also raises the risk of stenosis of the stoma in the future.

T. If either more than several weeks since the initial operation has passed, or the bowel cannot be sufficiently mobilized via the abdominal wall opening then formal laparotomy or laparoscopy may be required in order to achieve adequate bowel mobilization. Some of the tips noted above can be used to help mobilize the bowel as required.

Refer to Algorithm in Fig. 79.2D Management of Stenosed Stoma

U. In one series 60% of stomal strictures were managed conservatively, 20% of stomal strictures were managed with local procedures to release the skin and 20% required formal relocation. It is of upmost importance to rule out recurrence or progression of disease underlying disease. Therefore, before surgical intervention is undertaken some form of imaging or endoscopy should be considered. The initial management of stomal stricture can be conservative. Diet modification if the stricture is mild or catheter insertion and irrigation to loosen stool and can significantly improve symptoms.

V. Dilatation of the stenosed stoma should generally be avoided due to high failure rate. Although digital dilatation is one option, serial Hegar dilators can be used if a more formal approach is desired. It should be noted that tissue trauma during dilatation often leads to fibrosis and either recurrence or worsening of stomal stricture. Nevertheless, in those patients for whom relocation is not an option, repeat dilatations remain a possible course of treatment.

W. Ultimately, whatever way a skin or fascial incision is made surrounding a stoma suffering from established stricture, subsequent scar formation around these incisions results in a high failure rate of all of these local procedures. Hence if conservative management fails and the stenosis is still symptomatic, refashioning of the stoma is often required. This almost always entails laparotomy or laparoscopy to allow mobilization bowel once the stoma has been divided from the bowel wall. The part of the bowel that once formed the stoma is often resected especially if it includes an area of disease. The same stoma site can often be used but requires the margins to be re-excised in order to be sufficiently large to receive the new stoma and prevent recurrence of stricture formation.

The Role of Laparoscopic Surgery

X. If the stoma is being refashioned, it can then be sharply divided from the abdominal wall and inserted back into the abdomen whilst being held by Allis forceps or a long suture. This is best done after the laparoscopic stage as maintaining pneumoperitoneum may otherwise be difficult. The abdominal wall opening can then be debrided and extended as necessary. Once the abdominal wall is ready, the stoma can be manually pulled through the opening and the stoma refashioned. Care should be taken when skeletonizing the bowel to ensure that ischaemia of the distal limb does not occur. It is obviously important to avoid damage to bowel that may be adherent to the abdominal wall during trochar insertion.

Y. If the stoma is being re-sited, a 5 or 10 mm trochar can be placed where the new stoma site has been marked. Once the bowel is adequately mobilized, it must be closed with a linear stapler or over sewn with sutures, inserted into the abdominal cavity and then grasped with atraumatic laparoscopic forceps via this trochar. The abdominal wall opening can then be created, ensuring a cylinder shape is made around the trochar. The bowel can then be pulled through the abdominal wall with the trochar. The stoma can then subsequently be fashioned.

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80 Stomal Varices

Sean J. Langenfeld

Background

Patients with surgically created stomas can start with or develop liver disease in their lifetime, often as a result of the same pathology that required fecal or urinary diversion. When these patients develop gastrointestinal bleeding, the astute clinician must always be aware of the possibility of variceal hemorrhage originating from the stoma's mucocutaneous junction.

Stomal varices were first reported in 1968 by Dr. Reznick et al. in a randomized controlled trial of patients undergoing colonic bypass to reduce hepatic encephalopathy. In this study, cirrhotic patients underwent an internal bypass with an ileosigmoid anastomosis in an attempt to reduce the amount of ammonia produced by the colon, and the terminal ileum distal to the anastomosis was brought out as a mucus fistula. Not surprisingly, the morbidity and mortality for this procedure was quite high, and the authors noted stomal varices with hemorrhage in 15% of patients.

Since its initial description almost 50 years ago, our knowledge of stomal varices has improved, but the current literature still lacks a reliable algorithm for management, and there is disagreement among experts regarding the best approach to acute and chronic variceal hemorrhage. The aim of this chapter is to provide an updated summary of the clinically relevant aspects of stomal varices, and develop a reliable algorithm for the diagnosis and management of variceal bleeding.

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Etiology

A stomal varix is an acquired communication between the portal and systemic circulation that occurs due to portal hypertension. The bowel submucosa contains veins that drain into the portal venous system, and because of increased pressure, they develop collateral communications with veins of the abdominal wall. Since this process requires portal hypertension, it is almost always secondary to liver failure, which can occur due to many reasons including Hepatitis C, alcohol abuse, primary sclerosing cholangitis (PSC), or extensive hepatic tumor burden in patients with Stage IV malignancies.

Stomal variceal hemorrhage is usually due to local trauma related to pouching or other components of stoma care, but it can also occur spontaneously due to vessel erosion through the stoma's mucocutaneous border.

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Epidemiology

Most studies describe bleeding stomal varices as rare, with a 1990 review finding only 75 cases in the literature and a 2013 review reporting 235 cases. However, the incidence is likely underreported, and other case series estimate the incidence among patients with liver failure and intestinal stomas to be 5–30%.

Stomal varices are more common in men, but it is unclear if this is due to a specific predisposition to varices, or if it simply reflects the higher incidence of liver disease among males. The most common cause of liver failure among patients with stomal varices is Primary Sclerosing Cholangitis, which can be partially attributed to the relationship between Ulcerative Colitis (UC) and PSC, with many of these patients requiring temporary or permanent stomas. Indeed, the most common abdominal pathology leading to stoma formation in this group is UC (58%), followed by rectal cancer (23%) and cancer of the urinary tract (9%). Of note, the incidence of stomal varices is similar between patients with PSC and other causes of liver failure.

Variceal hemorrhage can be associated with any type of intestinal stoma, including ileostomies, colostomies, urostomies, loop stomas, and defunctionalized stomas or "mucus fistulas". In general, about 70% of variceal bleeds occur from ileostomies, 20% from colostomies, and 10% from ileal conduits.

Clinical Presentation

Refer to Algorithm in Fig. 80.1

Stomal varices usually take time to form, and variceal hemorrhage typically occurs 2–4 years after stoma creation. However, it has also been described in the immediate postoperative period (range 1–480 months).

A. Patients may present with intermittent low-volume bleeding, or they may experience high-volume bleeding with associated anemia. Blood may be bright red or dark purple in color. The bleeding usually occurs from the mucocutaneous junction, and consists of a brisk, non-pulsatile flow. The bleeding can at times be quite dramatic depending on the degree of portal hypertension, and some case reports include descriptions of blood squirting long distances from the skin edge.

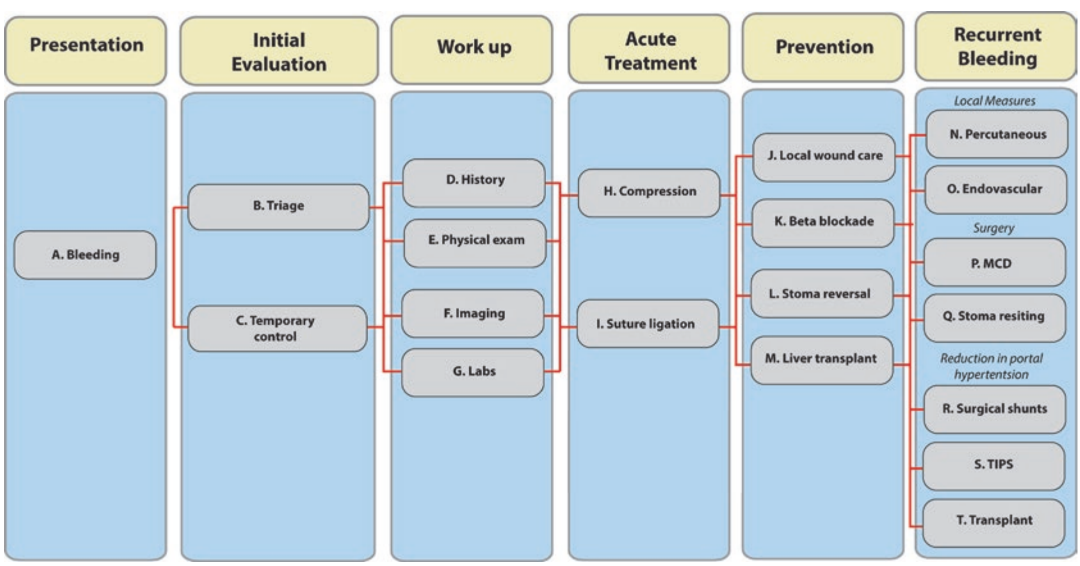

Fig. 80.1 Algorithm for the diagnosis and treatment of stomal varices

Unfortunately, this bleeding is often attributed to the gastrointestinal tract rather than the skin edge, and a lengthy and fruitless evaluation including expensive imaging and pan-endoscopy can occur if the clinician does not remove the stoma appliance and inspect the stoma itself. One case series reported this to be the case in 25% of patients with bleeding stomal varices.

Because of their comorbidities, patients may also present with decompensated liver failure at the time of stomal hemorrhage. Some patients may also describe similar episodes of bleeding in the past, regardless of whether or not the bleeding was previously localized to the stoma.

Fig. 80.2 Ileostomy with classic appearance of the peristomal skin. (Courtesy of Patricia Roberts, MD)

Evaluation

Triage and Temporary Control of Bleeding

B. Stomal varices should be treated similar to other causes of GI hemorrhage. Specifically, the clinician should ensure that the patient is in a location with sufficient resources such as emergency room, intensive care unit, or operating room, has adequate intravenous access, and receives ongoing resuscitation during the workup. It is important to remember that this patient population tends to have several other comorbidities that require attention, and the clinician should assess the patient's degree of global dysfunction.
C. While more information must be obtained from the patient, the first step is to obtain temporary control of the bleeding with direct pressure applied to the site of hemorrhage. This prevents unnecessary blood loss during a detailed evaluation.
D. History: The clinician should determine the cause of the patient's liver disease, as well as the reason and timing of stoma creation. Medications and comorbidities which may be contributing to coagulopathy and hemorrhage should be reviewed.
E. Physical examination: Patients may exhibit other signs of liver failure including jaundice, cachexia, caput medusae, hepatomegaly, and hepatic encephalopathy. A comprehensive head-to-toe exam is warranted, and it is essential that the primary survey include complete removal of the stoma appliance and a detailed stomal exam, as this can save an expensive workup for other sources of hemorrhage.

   After removal of the stomal appliance, the clinician will encounter brisk non-pulsatile bleeding from the mucocutaneous junction, typically in a single location. The surrounding peristomal skin often has a bluish discoloration (Fig. 80.2), but this is only present in one-third of patients with stomal hemorrhage.
F. Imaging: Specific imaging is not necessary for patients with stomal hemorrhage.
G. Laboratory tests: Complete Blood Count, International Normalized Ratio, and a Comprehensive Metabolic Panel are warranted to determine the extent of hepatic disease, coagulopathy, and anemia. These values will guide resuscitation.

Treatment

Acute Treatment

Acute bleeding almost always responds to local bedside measures, but recurrent hemorrhage is universal. The best definitive treatment is to correct the patient's underlying portal hypertension, as any measure aimed specifically at the offending vessel is temporary, and new collaterals will form.

H. The immediate goal of bedside intervention is to stop active hemorrhage. The simplest way to achieve this is through direct pressure, often with the assistance of epinephrine-soaked gauze. This results in temporary source control for the majority of patients.
I. When direct compression is unsuccessful, bleeding can be controlled with suture ligation. An absorbable suture is typically used to eliminate the need for future removal. A tapered needle should be employed, with braided and monofilament sutures having equal efficacy. The purchase should go across the mucocutaneous junction in a simple interrupted or figure-of-eight manner.

Prevention of Recurrent Bleeding

J. Pouching issues often contribute to local trauma, and the only effective mechanical measure for the prevention of recurrent bleeding is modification of the stoma appliance. This often involves a stoma nurse to help the patient get re-fit for a new appliance with less potential for stomal trauma.
K. Beta-blockade is well-described for the primary prevention and treatment of bleeding esophageal varices, and it has also been described for the prevention of recurrent stomal hemorrhage with mixed results. A single case series reported long-term success in three patients treated with propranolol, with dosage aimed at a 25% reduction in heart rate. At this point, there is inadequate evidence to support routine use of beta-blockade, but it is certainly an attractive alternative to larger interventions.
L. The stoma's utility should also be determined, and if the stoma is no longer necessary, the surgeon may consider stoma takedown as an effective means to prevent future hemorrhage, as this effectively interrupts the portosystemic communication. Of note, many patients will have comorbidities that limit their ability to tolerate an elective surgery. Their surgical history is also important, as loop stomas are easier to reverse than end stomas, and a hostile open dissection in a coagulopathic patient may not be the best path to choose.
M. In addition to consideration for stoma reversal, the surgeon must also assess the patient's candidacy for liver transplant. This is a complex decision based on the patient's severity of disease and overall prognosis, and liver transplant should not be considered solely for the treatment of variceal hemorrhage.

Treatment of Recurrent Bleeding

When bleeding recurs, repeat suture ligation can be employed, and there are several more aggressive local measures, which will be described below. The best approach to recurrent bleeding is not well-defined, and existing literature is mostly in the form of small case series. Many of these studies are old, without much activity in the last 20 years. As stated before, local measures have only temporary efficacy because the main underlying issue is portal hypertension. It is also important that the clinician cater the treatment to the patient, as they may present with fulminant liver disease and a limited liver-specific life expectancy, in which situation smaller interventions are preferable. Most patients will succumb to their liver disease prior to experiencing life-threatening stomal hemorrhage.

Local Measures

N. Percutaneous interventions: Overall, percutaneous treatments are safe with reasonable short-term outcomes, but many complications have been reported, and case series are small. In addition, multiple applications may be necessary to achieve the desired effect.

   Injection sclerotherapy has been well-described for the local obliteration of stomal varices. It can be done to treat acute bleeding or to prevent recurrent hemorrhage after temporary hemostasis. In general, a sclerosing agent is injected directly into the offending vessels, either through the stomal mucosa or

percutaneously through the peristomal skin. In some newer series, ultrasound guidance has been employed with good short-term outcomes. Several sclerosing agents have been described, similar to what is used for hemorrhoids, and there is no evidence that one sclerosing agent is superior. Success with this technique is modest, and described solely in small case series. Skin necrosis and stomal stenosis have been reported with this technique as well.

Percutaneous embolization has also been described using both ultrasound and fluoroscopy. A combination of endovascular coils and Histoacryl glue is typically employed. Of note, coil migration has been reported. This technique is newer and has less supporting evidence than sclerotherapy.

O. Endovascular interventions: Angiography with endovascular coil embolization has also been described in small series, and is a viable option for patients who continue to bleed, and are not candidates for surgical intervention. Sclerosing agents can also be injected in this manner.

Surgery

P. Mucocutaneous disconnection (MCD) was popularized in 1988 by Drs. Beck, Fazio, and Grundfest-Broniatowski. This technique interrupts the portosystemic collaterals surgically without the need to re-site the offending stoma. The authors conceded that new collaterals would eventually form in most patients, but opined that this technique often results in a sustained period of hemostasis, which is adequate for most patients with advanced liver disease.

The original description of this technique included an incision at the mucocutaneous border, direct variceal ligation down to the level of the anterior rectus sheath, and repeat maturation of the stoma in the same location. The authors reported universal technical success with roughly 200–300 ml of blood loss. In this author's experience, a helpful caveat is to include a small (1 mm) rim of skin so as to approach slightly proximal from the site of bleeding, and have a bipolar energy device available. Great care must be taken not to injure the adjacent bowel, and subcutaneous dissection should remain very close to the serosa if possible.

Q. Stomal re-siting is listed for historical purposes, but is generally not a preferable technique, as it does not provide any additional hemostasis or decrease in rebleeding rates compared to MCD. However, if there is a heavily symptomatic parastomal hernia, relocation may be necessary. If the stoma's location and profile are suboptimal, and this is contributing to local trauma and hemorrhage, then relocation is also reasonable.

Reduction in Portal Hypertension

Since portal hypertension is the true cause of stomal varices, techniques aimed at reducing portal pressures have the lower reported rates of rebleeding.

R. Surgical shunts: In the 1980s, the most commonly described method of portal decompression was surgical portosystemic shunting, including mesocaval and portacaval splenorenal shunts. Of note, rebleeding was very uncommon after these procedures, and usually occurred when the shunts occluded. However, these are very morbid procedures, and alter the anatomy making future transplantation more difficult, so they have a very limited role now that Transjugular Intrahepatic Portosystemic Shunting (TIPS) is available.

S. Transjugular Intrahepatic Portosystemic Shunt: TIPS has long been known to reduce portal hypertension without requiring major abdominal surgery or altering the patient's anatomy. It was first described for the treatment of variceal hemorrhage in the early 1990s, and it has become increasingly prevalent since then. When technically feasible, TIPS is associated with nearly-universal short-term success, and the lowest reported

rate of rebleeding (20% for TIPS vs. 80–90% for local measures).

Rebleeding can occur after TIPS, typically due to shunt occlusion and recurrent portal hypertension, so patients should be monitored closely for recurrent symptoms. TIPS can also worsen hepatic encephalopathy, so patients must be selected carefully, and TIPS is not appropriate for all patients with variceal hemorrhage.

T. Liver transplantation is discussed above (M), and is an effective means of reducing portal hypertension as well.

Summary

Stomal varices can result in significant hemorrhage. Local hemostatic measures are usually effective, but are associated with high rates of recurrent hemorrhage. Surgeons should be familiar with the technique of mucocutaneous disconnection for severe, recurrent bleeding. The most durable way to prevent rebleeding is to reduce portal hypertension, and TIPS is slowly emerging as the most promising non-invasive technique for portal decompression. Clinicians must balance interventions with the patient's liver-specific prognosis, as patients frequently succumb to their liver disease rather than to stomal hemorrhage.

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81 Stomas: Peristomal Skin Complication

Alex J. Ky and Nir Horesh

Refer to Algorithm in Fig. 81.1

Creation of a temporary or permanent ileostomy or colostomy is an essential part of the surgical treatment for a variety of clinical indications. Fecal diversion is used both in emergent and elective surgical settings, mainly to promote bowel healing and recovery. In acute care, colonic obstruction and colonic perforations are the most common etiologies for fecal diversion. Stomas may be created following severe post-operative complications including anastomotic leakage and in severe pelvic infections. Stomas may also be used preventatively, mainly in low rectal anastomosis, but also for oncological resection in anal and very low rectal malignancies.

The clinical indication plays a crucial role in several aspects of the stoma creation. First, the type of ostomy created is in direct correlation to the purpose the stoma serves. For example, diversion for colonic obstruction, most commonly seen in left sided colonic and rectal malignancies, needs colonic decompression because diversion at the terminal ileum does not resolve the effect the blockage has on the colon, due to the presence of the ileo-cecal valve.

Another important factor of stoma creation is the expectancy for stomal reversal. Small bowel ostomies are more prone to skin complications due to the irritating nature of the enteral content. Colostomies are considered more convenient for stoma management but are considered more difficult for surgical reversal, mainly because mobilization of the colon is often needed, which is less significant in the small bowel. Another important factor includes the location of the stoma, which changes not only due to the type of stoma, but is also related to the patient's body habitus. It has been proven that preoperative marking of the ostomy site by experienced ostomy nurses can reduce the possibility of stoma-related complications.

The type of ostomy also determines the content the stoma produces. As previously mentioned, small bowel stomas produce enteric content that is not only irritating to the skin but is often liquid in nature that may cause dehydration and electrolyte losses, resulting in severe electrolyte imbalance. Unlike colostomies, ileostomies and other small bowel ostomies require patient and caregiver follow up and, in some cases, medical interventions to control these losses.

Patients who receive a stoma for fecal or urinary diversion can develop peristomal complications. For patients with a permanent stoma, this is a lifelong issue. Patients undergo stoma creation

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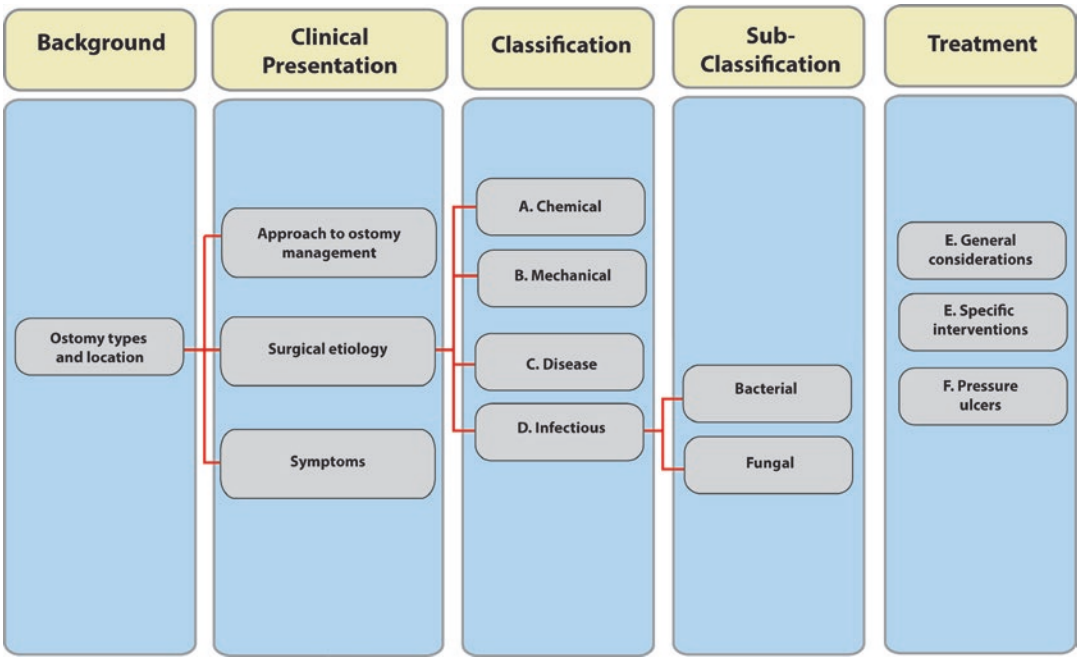

Fig. 81.1 Algorithm for perianal skin complications

for a variety of indications such as cancer, inflammatory bowel disease or temporary diversion until the index condition is resolved. Access to wound ostomy care (WOC) nurses or enterostomal therapists (ET) has significantly improved the prevention and treatment of peristomal complications. With the advent of shorter hospital stays, patients may not have ample time to become acclimated to a stoma. Most peristomal complications occur 5 years after creation of the stoma. The most common causes of peristomal skin complications are due to infection, chemicals, trauma, or leakage.

The key goal for the surgeon is a well-constructed stoma. Many stomal complications can be prevented with a well constructed stoma. When this is not achieved, the incidence of skin problem ranges from 10% to as high as 70%. Although involvement of WOCs and ETs perioperatively is an integral part of the stoma creation, unfortunately not all patients have access to such care. In these cases, the surgeon should be well versed in the management of stomal complications to educate the patient. The common symptoms related to peristomal complications include skin discoloration, polyp like growth, erythema, pain, and pruritus, which can lead to social isolation, poor self-image, a decreased quality of life and increased cost.

The World Council of Enterostomal Therapists (WCET) developed the Ostomy Skin Tool, which is divided into three major domains:

- D—Discoloration
- E—Erosion/ulceration
- T—Tissue overgrowth

The Ostomy Skill Tool ranges from of 0 to 15, with 0 being normal; mild can be considered as ≤4, moderate >4 to ≤7 and >8 for severe.

Four categories that describe peristomal irritations include:

1. Chemical
2. Mechanical
3. Disease
4. Infection

A. Chemical

This is the most common cause of peristomal irritation. A potential allergen provocation can evoke a response with antibody production, causing skin inflammation. This is often caused by allergens to adhesives (Fig. 81.2). Effluents of feces/urine are caustic chemicals that can also cause chemical burn and irritation when in contact with the skin. The length of exposure as well as the caustic nature of the chemical affects the degree of skin irritation. Treatment includes removal of the offending agent. An important aspect of care is properly educating the patient. Leakage can also cause difficulty in pouching, which in turn causes further leakage, chemical irritation and skin inflammation. This can be even more distressing for a patient with a new stoma.

A study in 2010 that included 89 patients showed a 50% skin complication rate following the creation of an ostomy after 1 year. Fifty percent of the skin complications resulted from leakage. Up to 85% of all patients have leakage during the lifetime of the stoma. Leakage usually occurs when the enteric content is consistently fluid and when the ostomy bag is more than half full.

There are other causes of chemical irritation. Dermatitis can be caused by the adhesive, the pouch, the belt, or the skin barrier. Most manufacturers of ostomy products provide a patch test to test for chemical allergies. Allergic dermatitis is rare and accounts for 0.6% of peristomal dermatitis.

B. Mechanical

Mechanical causes of peristomal dermatitis are mostly related to ill-fitting appliances with mechanical stripping from the pouching system or its removal. Irritation can be the result of pressure, the cleaning process, frequent changes of the pouch, and in patients with intrinsic fragile skin.

Pressure on the skin from the convex flanges or by the belt may cause pressure ulcers. Some pressure ulcers can progress to full-thickness damage and ulcerating. This is challenging to heal since most patients who wear a convexity require it to keep a good seal, otherwise they experience leakage.

Frequent pouch changes strip away the epidermoid layer, leading to irritated red painful skin (Fig. 81.3). The exposed stratum corneum can

Fig. 81.2 Chemical peristomal irritation. Chemical irritation of the skin due to recurrent leakage from the ostomy causing significant erythema and skin changes around the ostomy site

Fig. 81.3 Mechanical peristomal injury. Mechanical irritation due to allergy and pressure from the ostomy pouch system with periostomy inflammation from caustic enteric material. Adjustment of the stomal equipment is key in managing and preventing peristomal skin disorders

become scaly and excoriated and macerated from the trauma. A poorly formed stoma that is placed too close to a bony prominence causes uneven flatness close to the umbilicus that can lead to an ill-fitting appliance. A retracted or flushed stoma can lead to excoriated and denuded skin, which in turn makes it harder to achieve a good seal.

Newly created stomas tend to swell. Thus the appliance may not be still be appropriate after the swelling is reduced. A convexed pouch may be needed until the skin heals and is then subsequently reassessed to ensure it is still appropriate.

C. Disease

Patient can experience peristomal skin complication from their disease. Pyoderma gangrenosum was first described by Brunstig and colleagues in 1930. Peristomal pyoderma gangrenosum presents with peristomal ulcerations. It is associated with malignancies, blood dyscrasias, diabetes, and hepatitis. Presentation is well-defined pustules that erupt and coalesce into a classic painful ulcer with bluish purple coloration around the edges. When this presents, it is important to rule out infection before making a diagnosis. Pouching becomes a challenge in pyoderma gangrenosum due to the proximity to the stoma.

Treatment for pyoderma gangrenosum often involves pain management and topical and injectable corticosteroids. Crohn's disease can also present with peristomal skin ulcerations. In prolonged peristomal disease, adenocarcinoma should also be ruled out. Foam dressing over the ulcerations may help. Silver dressings in sheet form or calcium alginate have also been effective. The goal of therapy is to absorb the moisture and allow the appliance to adhere without leakage.

Pre-existing Conditions

There are pre-existing medical conditions that present with skin complications and include psoriasis, seborrheic dermatitis hyperplasia, and atopic dermatitis. Overgrowth of cells appear as grey, reddish brown pseudo verrucous lesions. This can occur with urinary ostomies. Treatment is vinegar soaked gauzed.

D. Infectious

Infectious dermatitis can have fungal or bacterial etiologies. The two most common infectious complications are bacteria causing folliculitis and candida causing fungal infection.

Bacterial

Folliculitis is infection of hair follicles causing pustules and irritation. Staph aureus is the most frequent microbe leaving a red pustular area resembling candidiasis. This is most commonly caused by traumatic hair pulling during removal of the pouch.

Treatment for this condition includes antibiotics and proper hair removal.

Fungal

Candida albicans is the most common cause of peristomal fungal infection (66% of skin infections). The warm, moist, and dark environment of the peristomal skin area is ideal for yeast proliferation. Any leakage or immunosuppression of the patient further contributes to fungal overgrowth.

Peristomal dermatitis from fungus presents with erythematous, shiny patches with satellite papules, pustules and lesions. Treatment is antifungal powder. The use of azole family medications such as miconazole and clotrimazole are good first line treatments. The allylamines are suggested for patients who have failed or are resistant to over-the-counter agents. If antifungal medications do not eradicate the problem, antibacterial powder is indicated; bacterial infection can also resemble candidiasis.

E. Therapy in Prevention of Peristomal Skin Complications

Involvement of WOCs of ETs is an integral part of the perioperative care of a patient receiving a stoma. For patients without access to these professionals, the operating surgeon should be well verse in the creation and care of a stoma to address and prevent skin complication.

An ill-fitting pouch that is too big leaves a large area of exposed skin, causing caustic output from the digestive tract rich in digestive enzymes to come into contact with the skin. Once the skin becomes denuded, it is much harder to get a good seal. Often, pouches with convexity are indicated. Once the skin is healed, reassessment is important ensure that the convex wafer shape is still the best option.

Treatment of denuded skin—No sting liquid barrier/skin sealant: this provides a protective film and helps to keep the area dry.

Skin sealant—This allows for less leakage and reduces epidermal stripping.

Light dusting powder—Allows for drying the skin.

Light coat of calamine lotion—Protects the exposed denuded skin.

The best course of action is to determine if the pouch used is appropriate to alleviate skin complications.

F. Pressure Ulcers

Pressure ulcers are often caused by the belt or the convex flanges of the pouch. This is especially common in patients with peristomal hives. Some ulceration can progress to full thickness injury (Fig. 81.4). Once again, this is time to evaluate the appliance and to treat the skin ulcerations.

Fig. 81.4 Skin ulceration with subsequent wound infection. Significant irritation of the peristomial skin can cause serious skin ulceration and injury. Leakage from the ostomy can also cause significant wound infections that often require readjustment of ostomy apparels to allow healing. Topical agents like silver nitrate are used commonly in these situations

Summary

Important steps in the prevention and treatment of peristomal skin irritation include:

- Preoperative marking of the stoma site
- Proper creation of the stoma
- Involvement of an enterostomal therapy nurse
- Proper fitting of the pouch
- Use of various pouches options (convexity), when needed, to heal the skin
- Reassess proper fit of a pouch on a regular basis
- Early intervention of skin complications

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Part VIII

Complications

82 Complications: Ureteral Injury

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Refer to Algorithm in Fig. 82.1

A. Iatrogenic ureteral injury (IUI) during colorectal surgery and other pelvic procedures is an uncommon, but serious, complication (Fig. 82.2). Colorectal operations are the third most common cause of ureteral injury, with a higher incidence reported in endourological procedures and gynecologic surgery, respectively. Reviews and current series reveal a lower incidence than past estimates, with most reporting injury in less than 0.5–1% of cases. Rectal surgery, as a subset, still has a higher rate of IUI, at approximately 1–5%.

Whether laparoscopy is associated with higher incidence of IUIs is debated in the colorectal literature. The persistent drawback to a laparoscopic approach is the lack of tactile feedback, making ureteral identification dependent on visual cues alone during delicate dissection. In cancer cases, when stratified by tumor site, the increased risk associated with a laparoscopic surgical approach may persist only for rectal tumors. A robotic approach may provide an advantage in pelvic dissection, which in theory would decrease injury to the distal ureter, but there is no available literature at this time to support this notion.

The surgeon should be aware of the potential for IUI, whether undertaking an open or minimally invasive approach, and review the risk with patients as part of the informed consent process.

B. The surgeon must have a clear understanding of the retroperitoneal anatomy. Meticulous surgical technique and proper definitive visualization of the ureter is the best way to prevent iatrogenic ureteral injury regardless of surgical approach. Typically, the ureters can be visualized through the overlying parietal peritoneum. The ureter vermiculates with gentle stimulation, distinguishing it from vascular structures and confirming the identification. Following

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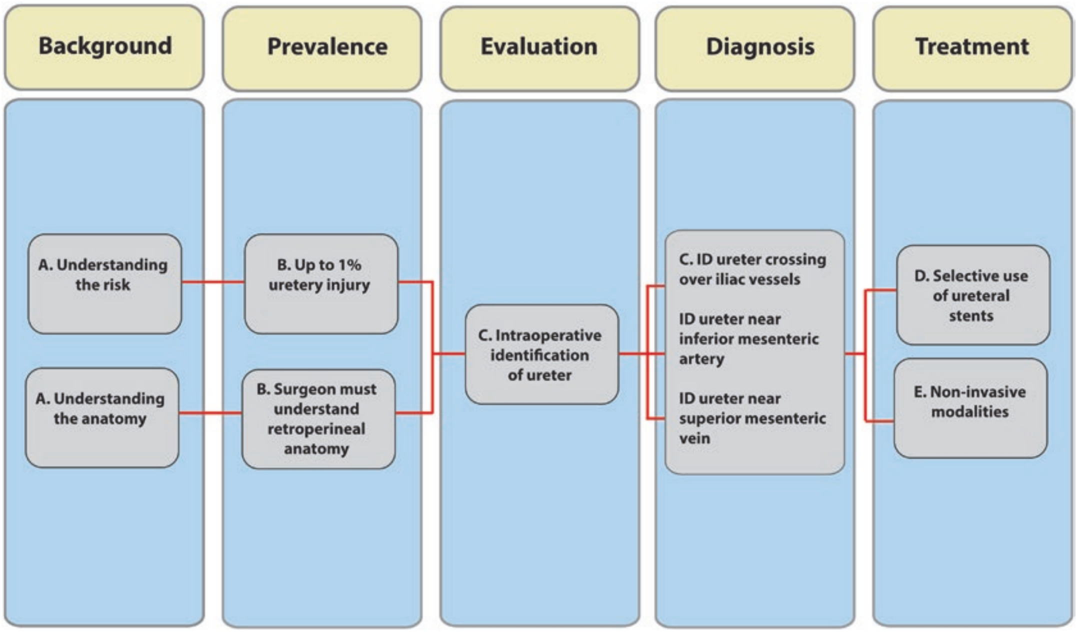

Fig. 82.1 Algorithm for ureteral injury complications

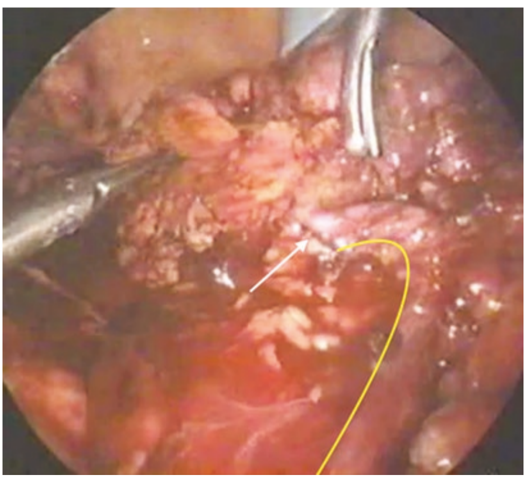

Fig. 82.2 Yellow line traces the undersurface of the transected ureter during a laparoscopic colectomy. Arrow points to the transection (Courtesy of Scott R. Steele, MD)

identification, meticulous dissection and a thorough understanding of relevant anatomy are necessary to trace the course of the ureter and avoid complications. The proximity of the ureters to the field of dissection make them more often injured during ligation of the inferior mesenteric vessels, dissection at the level of the sacral promontory where they cross over the iliac artery, division of the lateral rectal stalks in the pelvis, and the most cephalad portion during perineal dissection (Figs. 82.3 and 82.4).

The distribution of ureteral injuries is likely due to the anatomic relationships at these sites. A predominance of IUIs occurs at the distal ureter, regardless of laterality. Injury to the ureter can occur on either side where its course over the sacral promontory at the pelvic inlet and deep in the pelvis. The surgeon must not be lulled into a false sense of security by only visualizing the left ureter during pelvic dissections, it is paramount to clearly visualize both left and right ureters as the cross over the iliac vessels and trace both into the deep pelvis.

In contrast, proximal injury to the left ureter is more frequent than the right, likely due to the proximity of the ureter to the point of ligation of the inferior mesenteric artery. This is particularly of concern in sigmoid colon resections, low anterior resections, and left colectomy procedures, where the inferior mesenteric vessels

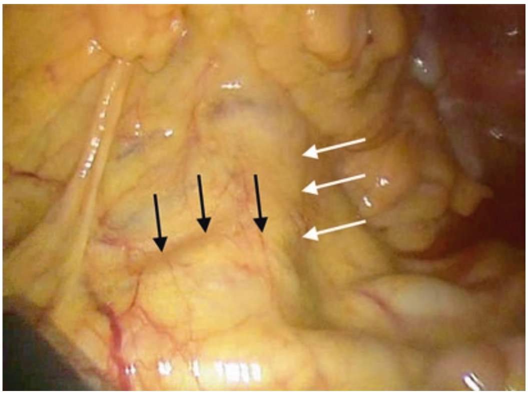

Fig. 82.3 Left ureter covered with peritoneum indicated by white arrows crossing over the left iliac vessels demonstrated with black arrows

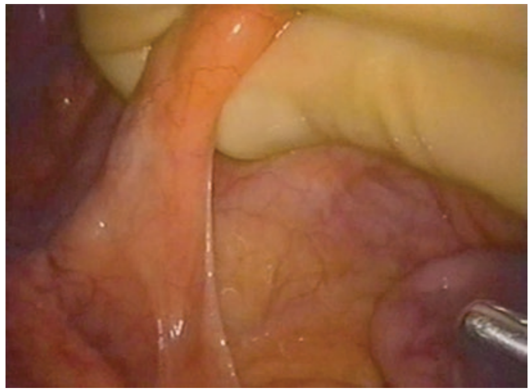

Fig. 82.5 Inferior mesenteric artery (IMA)

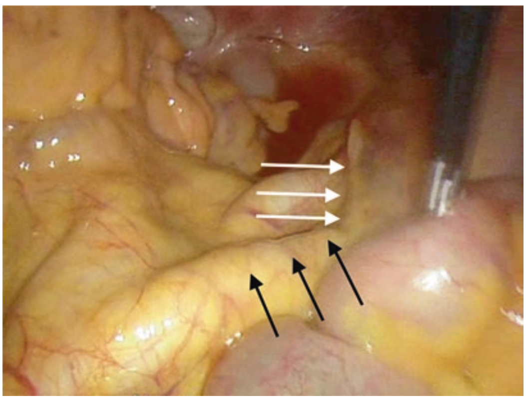

Fig. 82.4 Right ureter covered with peritoneum indicated by white arrows crossing over the right iliac vessels indicated with black arrows

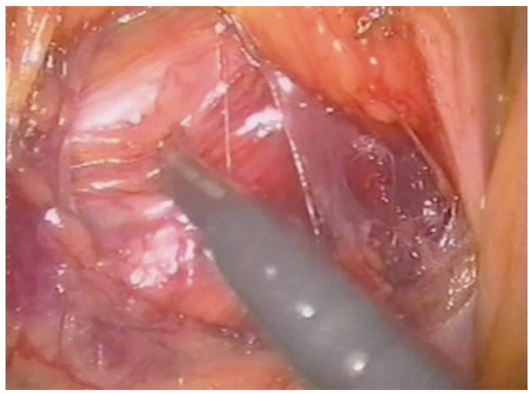

Fig. 82.6 Ureter close to inferior mesenteric artery

are constantly in the field of surgery (Figs. 82.5 and 82.6). Also the surgeon must take care of visualizing the proximal left ureter when mobilizing the splenic flexure and particularly when a high ligation of the inferior mesenteric vein is done close to the ligament of Treitz (Fig. 82.7). The laparoscopic approach is associated with more frequent left-sided IUI, as well.

Although infrequent the surgeon should be aware of the duplicated ureter, a congenital condition with an overall prevalence of approximately 1%. The colorectal surgeon should take measures to identify duplicated ureters on preoperative imaging. If unrecognized at the time of surgery, inadvertent injury may occur to the unidentified, unanticipated ureter.

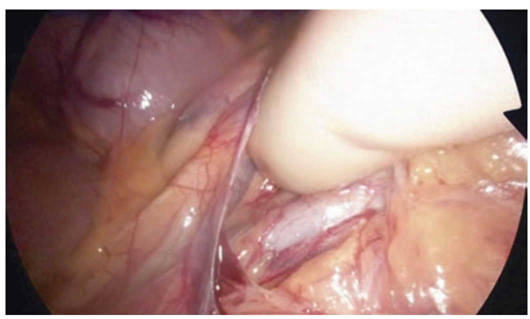

Fig. 82.7 Inferior mesenteric vein (IMV) and ureter

C. Intra-operative identification of ureteral injury is of utmost importance. Morbidity and mortality are significantly higher when diagnosis is delayed. The nature of surgical ureteral injury includes ligation, kinking, transection,

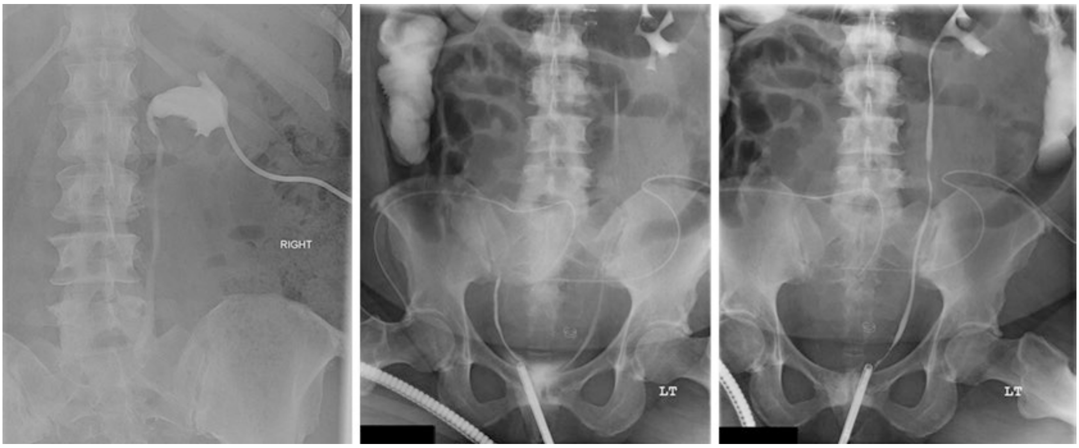

Fig. 82.8 Right ureter injury. Left: demonstrates a contrast study thru a nephrostomy tube. Contrast flows thru the nephrostomy tube and fills the right collecting system and down the proximal and mid right ureter. The distal ureter is not visualized; Middle: Retrograde cystourethrogram demonstrates a cystoscope in the bladder with contrast flowing thru the distal right ureter, however an abrupt flow of contrast at the level of the pelvic inlet is demonstrated. This indicates a complete injury of the mid right ureter; Right: Retrograde cystourethrogram of the left ureter and collecting system is normal (Courtesy of Daniel Feingold, MD)

crush, cauterization, and devascularization, and is an important consideration when determining management methods. When ureteral injury is suspected, the entire course of the ureter should be inspected to locate it, determine the type of injury, and identify any additional sites of injury. Ureteral catheter placement, cystoscopically or via cystotomy (Fig. 82.8), can help identify the site of injury. Intravenous methylene blue or indigo carmine can confirm urinary leakage and localize a partial or complete transection, when suspected, but may also be of limited utility in patients with renal impairment. Intraoperative cystoscopy and retrograde pyelography can provide radiographic evidence of extravasation or obstruction, if not provided by other modalities, but does require the use of fluoroscopy. Although more difficult intraoperatively, an intravenous pyelogram, with a bolus of IV contrast and abdominal X-ray or fluoroscopy, can demonstrate the same information. Conversion to an open procedure may be required if suspicion of an undiagnosed IUI remains high despite a thorough laparoscopic examination.

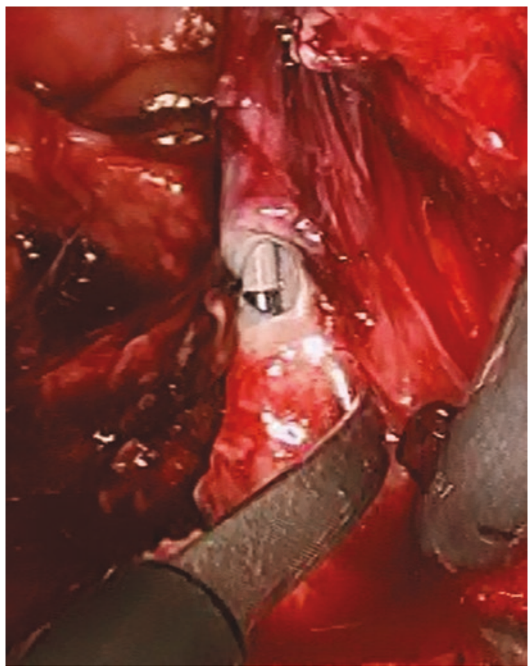

Fig. 82.9 Intraoperative ureter injury: Left ureter injury with stent visible. The injury occurred during laparoscopic resection of sigmoid colon with extensive endometriosis. Stent had been placed preoperatively and injury was identified immediately. The ureter injury was repaired primarily with absorbable sutures and stent in place (Courtesy of Daniel Feingold, MD)

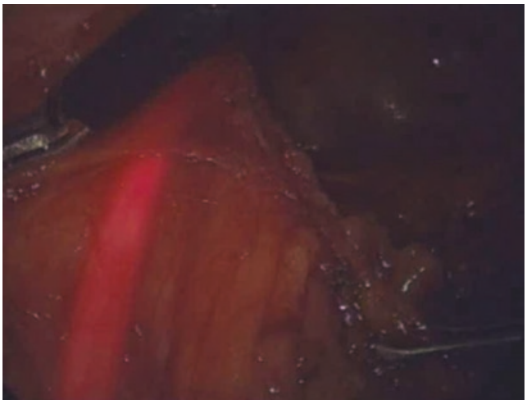

Fig. 82.10 Lighted stent in left ureter

The use of prophylactic ureteral catheters can aid in the palpation of the ureter and recognition of operative injury (Fig. 82.9). The rate of recognition of IUI at the time of the original procedure has improved overtime from 15% to 90%, and nearly 100% when ureteral stents are utilized. Illuminated/lighted ureteral catheters are available to enhance visualization of the ureters and enabling identification through tissue layers (Fig. 82.10). Removal of the dependence on tactile feedback makes lighted ureteral catheters more useful and applicable in minimally invasive approaches, such as laparoscopic or robotic procedures.

D. In addition to injury recognition, prophylactic placement of ureteral catheters provides a theoretical reduction in the chance of IUI during pelvic surgery. Their use in ureteral injury prevention is still controversial due to the overall low, but not insignificant, risk of ureteral trauma and associated deleterious effects related to retrograde insertion and the prolongation of operative time. Historically, prophylactic ureteral catheter placement has been associated with an intraoperative complication rate of approximately 2%, ranging 1–7% in colorectal procedures. More recent literature, including moderate-sized series, reports lower rates, with no morbidity directly related to the ureteral catheters.

Additionally, the idea that more common post-operative complications, such as higher rates of urinary tract infection (UTI), retention, and hematuria, are attributed to ureteral catheter placement has been substantiated. Some series have observed a higher incidence of both UTI and retention in the group of patients not undergoing prophylactic catheter placement, suggesting no causal relationship. Hematuria is clinically insignificant in most cases. However, the use of prophylactic ureteral stents is not without serious complications, including perforation, obstruction, and hydronephrosis secondary to stricture or edema, which need to be considered before placement. In addition, one must consider the logistics of coordinating the urology team, expense and manpower issues. Patients must be counseled and consented appropriately prior to surgery regarding the risks and benefits of ureteral catheter placement.

It remains difficult to determine the effect of ureteral catheterization on overall operative time, as the population of patients generally requiring preoperative catheters generally have increased disease complexity, already prolonging operative time versus those with less complex pathology. However, most literature suggests overall operative time is increased by less than 30 min. Concurrent intraoperative (*vs*. preoperative) placement of ureteral catheters in this complex patient population may even reduce operative time by allowing faster identification of the ureters.

Selective use of prophylactic ureteral catheter placement is a precaution that is relatively safe, and should be considered for high-risk surgery involving bulky tumors, prior radiation, pre-existing hydronephrosis, obese patients, anatomic variants, and inflammatory processes or fistulous disease, as with diverticulitis or inflammatory bowel disease. Ureteral catheters may also have a role in laparoscopic surgery by decreasing the need for conversion to laparotomy secondary to a failure of identifying the ureter. The surgeon should be aware that this procedure may prevent and aid in intraoperative identification of ureteral injury in complex cases. Careful surgical planning must take place with identifi-

cation of potentially involved structures on preoperative imaging in high risk patients. If a portion of the genitourinary (GU) tract is difficult to identify or seems to be involved in the proposed surgical area, the surgeon should consider urologic consultation. In complex cases, multidisciplinary approach is key in planning the operative approach, defining the need for preoperative ureteral catheter placement, and confirming availability should operative assistance be required.

E. Non-invasive methods of identifying the ureter utilizing new technology may be an alternative to ureteral stents and eliminate the associated complications and concerns regarding operative time. Near-infrared (NIR) fluorescence imaging has been used to enhance the visual contrast between the ureter and surrounding tissues and afford real-time identification. Diffuse reflectance spectroscopy (DRS) and hyperspectral camera technology employs relative spectral features of the tissue to visually identify the ureter in surrounding adipose tissue. The spectra originate from intrinsic tissue properties, and eliminate the need for a contrast agent and associated complications. Intraoperative gamma probe localization of the ureters has also been described.

   Increased costs of image-guided surgery are substantial and include light sources, cameras, and dyes or tracers. Although worthy of recognition as an adjunct to delineate the ureter, clinical applicability and cost is balanced with the potential of reduced operative time, improved outcomes, and reduction in the risk of ureteral injury is yet to be determined. Currently, cost is prohibitive for routine use, limiting availability at most centers.

F. Recognized ureteral injury usually necessitates urologic consultation. In cases of simple, intraoperatively identified ureteral injury, a colorectal surgeon may proceed with the repair if experienced and comfortable. The type of ureteral repair is determined by the location and nature of the ureteral injury. If the injury is small, clean and athermal, management may be either primary repair using absorbable suture with indwelling ureteral stent placement allowing delayed closure. For complete transections and thermal injuries, the edge should be debrided back to viable tissue, and the ureter should be mobilized and spatulated for primary ureteroureterostomy or reimplantation to the dome of the bladder. Direct reimplantation with ureteroneocystostomy is appropriate for distal injury, but more proximal injuries require more complex surgical repairs to develop length and achieve a tension-free anastomosis. In the case of distal ureteral injuries in which length is a concern for repair, a number of approaches may be employed to provide a tension free repair. The bladder can be mobilized, occasionally through division of the contralateral vascular pedicle, and the dome secured sutured to the psoas muscle (Psoas hitch). Adhesions, prior radiation, and more proximal ureteral injury may limit the application of a Psoas hitch. A Boari flap of tubularized bladder can be fashioned for anastomosis with the ureter, and may be used in concert with a Psoas hitch to gain substantial length in the repair of distal ureteral injuries. An irradiated bladder poses a particular concern if it is devitalized of severely contracted. Urinary diversion, such as percutaneous nephrostomy tubes is considered if a tension-free anastomosis cannot be accomplished or the radiated tissue is unlikely to heal. Transureteroureterostomy is an option for the reconstruction of proximal, extensive ureteral injury. However, it carries a high risk of complication and need for revision. Additionally, involvement of the normal contralateral ureter for reimplantation makes is susceptible to injury as well. Renal autotransplantation and ureteral substitution (i.e. ileal ureter) are options for vast ureteral damage without viable proximal or distal segments. Ligation at the renal pelvis and placement of a nephrostomy tube to allow transport to an advanced urologic center may be necessary for these complex repairs. Coordination with a transplant team is essential if autotransplant is to be undertaken.

Drain placement near anastomotic repair is recommended. Indwelling ureteral stents should be placed at the time of reconstruction to support the anastomosis, provide a conduit for urinary flow, and reduce the chance of future stricture formation. A well-vascularized omental wrap or peritoneum may be used to wrap the anastomosis, especially those performed in radiated surgical fields. A Foley catheter should be maintained for a length of time determined by the type of repair to prevent the reflux of high pressure urine with voiding to the area of anastomotic repair.

Despite this adherence to principles, repairs may leak, fistulize, or stricture. The failure rate for iatrogenic genitourinary injury repairs during colorectal surgery is as high as 20%. Radiation, chemotherapy, and delayed repairs are clearly identified as significant risk factors for repair failures. Preoperative urologic consultation is advised in patients with complex colorectal pathology, to assist with multidisciplinary surgical planning and avoidance of untoward complications.

G. Depending on the mechanism and degree of injury, iatrogenic ureteral injuries may present the immediate perioperative period or in a delayed fashion. The most common presenting signs and symptoms are abdominal pain with peritonitis, leukocytosis, fever and nausea. Flank pain may or may not be present, and is more common with complete ureteral obstruction. A sizeable urinoma may present as a palpable flank mass.

If suspected, laboratory evaluation and a computed tomography urogram, with delayed phase imaging should be performed to delineate the relevant anatomy and continuity of the genitourinary tract (Fig. 82.11). Extravasated urine collecting near a ureteral injury may localize the point of injury.

Location and extent of the injury guides the repair of delayed-presentation IUIs, the same principles as intraoperatively identified injuries. However, delayed management and repair is associated with increased morbidity compared with intraoperative identification.

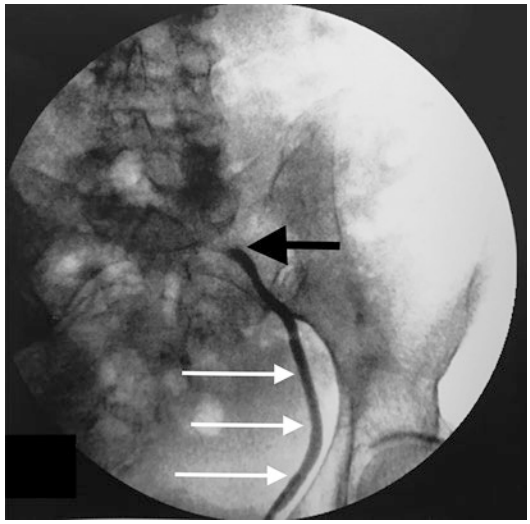

Fig. 82.11 Retrograde cystourethrogram demonstrates a complete mid-ureter injury. White arrows indicate the normal distal left ureter with filling of contrast from the bladder in a retrograde fashion. Black arrow indicates abrupt cutoff of contrast indicating a complete left ureteral obstruction/injury

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Splenic Injury Complicating Colorectal Surgery

83

Shlomo Yellinek and Petachia Reissman

Refer to Algorithm in Fig. 83.1

A. Anatomy

The location of the spleen and its relation to other organs is important in understanding the mechanism of splenic injury. The spleen is viscerally related to the greater curvature of the stomach, the tail of the pancreas, the left kidney and the splenic flexure of the colon. There are several ligaments with relation to the spleen: gastrosplenic, splenorenal, splenophrenic, splenocolic, presplenic fold, pancreaticosplenic, phrenicocolic and pancreaticocolic. The phrenicocolic ligament which extends from the diaphragm to the splenic flexure is sometimes foreshortened, pulling the splenic flexure towards the hilum or above the spleen and thus making its mobilization more difficult. The spleno-renal ligament contains the major splenic vessels and the gastro-splenic ligament contains the short gastric vessels. The spleno-colic ligament is often in proximity to the inferior pole artery of the spleen and thus susceptible to injury during splenic flexure mobilization. Figure 83.2 demonstrates a laparoscopic view of the spleen and its attachments. Figure 83.3 shows a case of very high position of the splenic flexure, which is located above the splenic hilum.

Anatomical variations of the splenic hilum, splenic artery and its segmental branches are common and well described in the literature. Such variations, in number and course of the terminal branches of the splenic artery at the hilum, may contribute to injury when dissecting the spleno-colic ligament.

B. Incidence and Risk factors of splenic injury in colorectal surgery:

Iatrogenic splenic injury is a recognized and potentially serious complication during different abdominal operations. However, the highest percentage (up to 50%) of all iatrogenic splenic injuries is related to colorectal surgery due to the close proximity between the splenic flexure and the spleen. The reported incidence of splenic injury ranges between 0.5% to as high as 8%. In most series, however, the incidence is less than 1%. Several risk factors of splenic injury were identified. Understanding these risk factors may help the surgical team in instituting risk reduction strategies and properly informing patients of the potential risk prior to surgery. In general, risk factors for splenic injury during colorectal surgery are shown in Table 83.1.

As a known risk factor to many complications, emergent surgery is a common risk factor of splenic injury, with an incidence of 1.28% *vs.*

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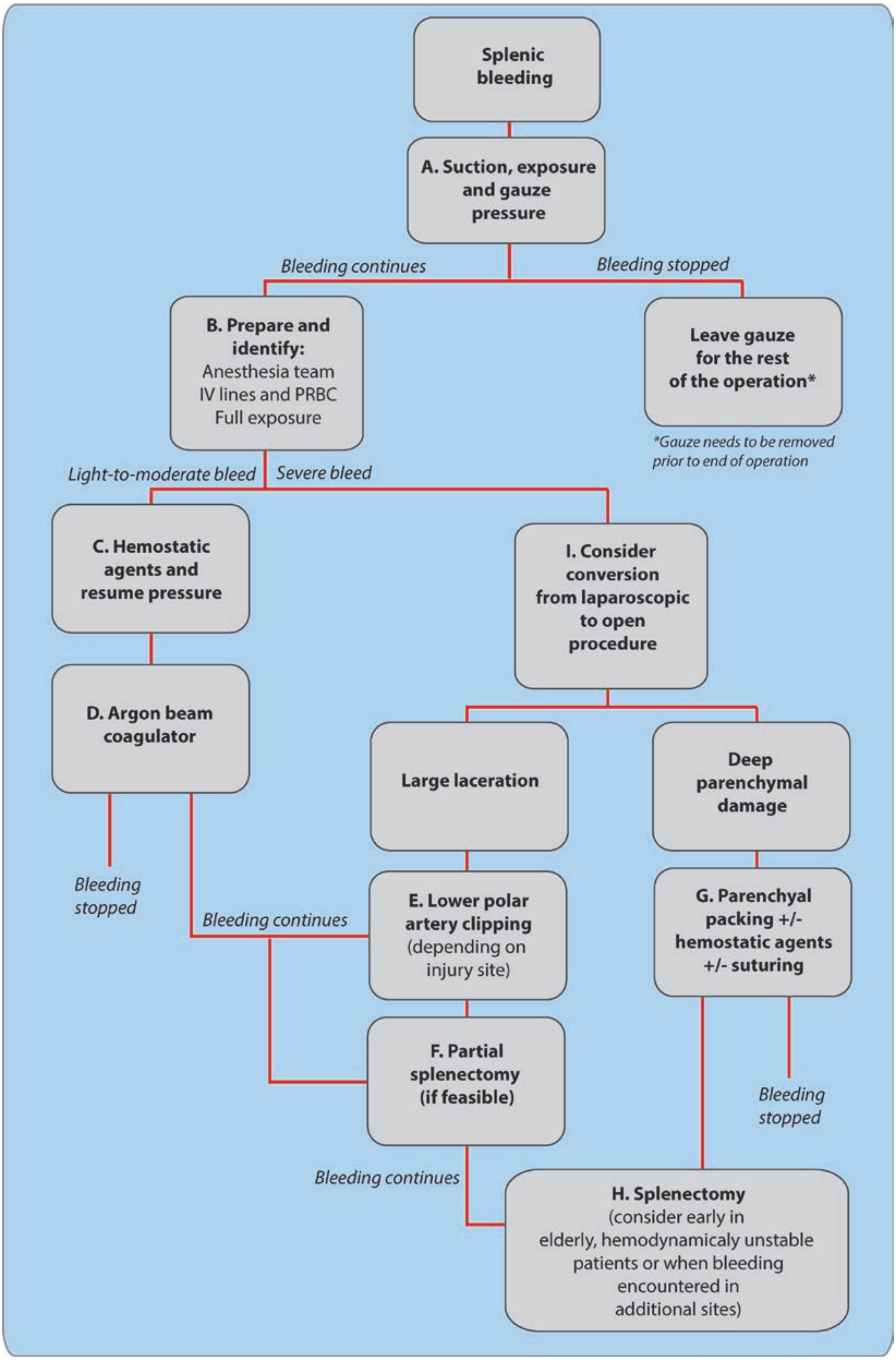

Fig. 83.1 Algorithm for splenic injury complicating surgery

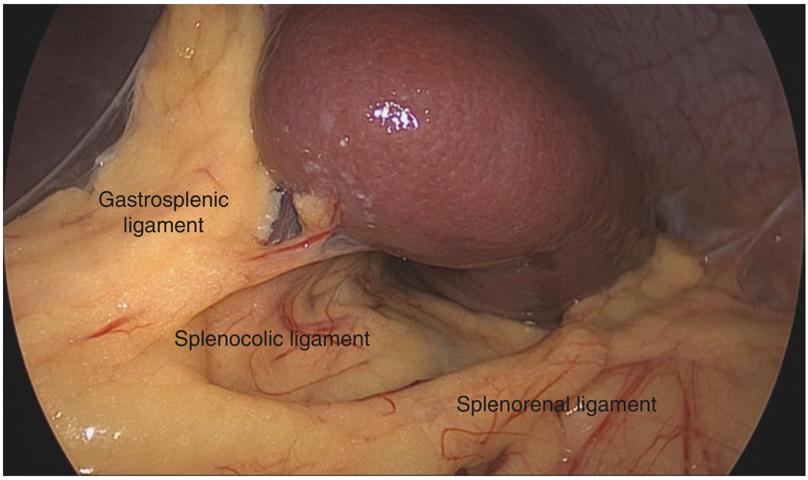

Fig. 83.2 Attachments of the spleen

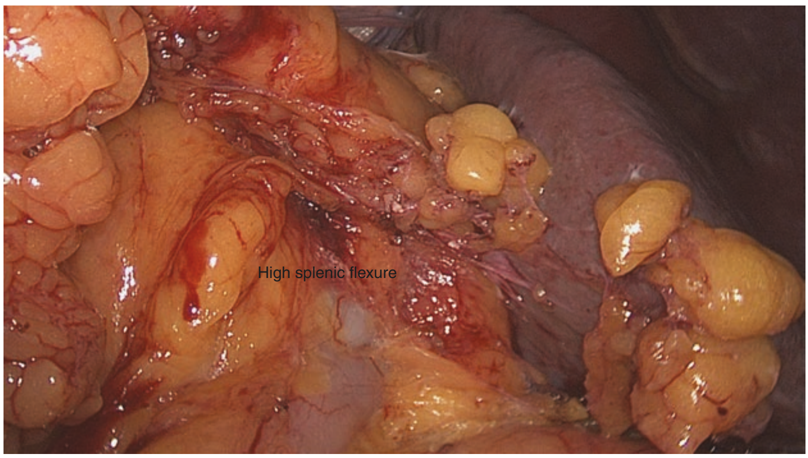

Fig. 83.3 A very high position of the splenic flexure above the splenic hilum

Table 83.1 Risk factors for splenic injury during colorectal surgery

Emergent operation
Sigmoidectomy/left colectomy operation
Open operation
Peripheral vascular disease
Cancer and diverticulitis

0.72% in elective cases. A higher incidence was observed in left colectomy/sigmoidectomy (2.8%) and subtotal/total colectomy (1.64%). Not surprisingly, Merchea and colleagues reviewed splenic injuries during colorectal surgery, reporting that 91% of injuries occurred in procedures that included splenic flexure mobilization. The rate of splenic injury was lower following laparoscopic surgery as compared to open procedures. Also, in a univariate regression analysis, Masoomi and associates showed that patients who had underwent an open procedure had a 3.41-fold higher chance of suffering a splenic injury compared with patients who underwent a laparoscopic procedure. In a more recent assessment of the ACS-NSQIP, Isik et al., also found that open colorectal resection was associated with a significantly increased likelihood of splenic injury (OR 6.58, $p < 0.001$). Co-morbidities such as peripheral vascular disease was also an independent risk factor of splenic injury, as well as cancer and diverticulitis.

C. Mechanism of injury:

There are few known mechanisms of splenic injury during colorectal surgery. The

most common mechanism is excessive traction on the ligaments attached to the spleen. During mobilization of the splenic flexure, infero-medial retraction on the colon takes place. If excessive force is used, the spleno-colic ligament will pull the spleen and a capsular tear may occur. Rarely, bleeding from the splenic parenchyma will follow. Unfortunately, as in any abdominal operations, previous abdominal surgery causes intra-abdominal adhesions and may contribute to limited visualization of the spleno-colic ligament and may require more traction force on the spleen.

A less frequent mechanism of injury is a direct mechanical injury of the spleen capsule or parenchyma caused by a surgical instrument like retractor, dissector, grasper or energy device in both open and laparoscopic surgery.

Finally, although rare, splenic injury may occur even if splenic flexure mobilization is not planned or performed. In such cases, greater omentum adhesions to the splenic capsule are present and traction on any portion of the omentum may transfer the pulling force to the spleen leading to avulsion and capsular tear.

D. Prevention of splenic injury during colorectal surgery:

Although the risk factors of splenic injury are a given conditions, splenic injury is a technical error and the surgeon must take all possible measures to avoid splenic injury.

In most cases, preoperative imaging like CT scan is available; the scan should review it carefully to determine the anatomic relations of the spleen, the splenic vessels and splenic flexure of the colon as anatomical variations are very common. For instance, if the colon is located high relative to the splenic hilum or even close to the diaphragm, its mobilization will be much more difficult compared to a low positioned splenic flexure. Surgical strategy and planning should be made according to such information. Another issue is previous surgery—attempt must be made to receive detailed information about previous abdominal surgical procedures. This way the surgeon can predict the presence of adhesions and possible changes in anatomy, allowing for better orientation in the present operation and potentially reduce the risk of splenic injury. In general, a well-informed surgeon who is familiar with the splenic anatomy and knows what to expect is less likely to injure the spleen.

Compared to open, laparoscopic colorectal surgery has been shown to be associated with lower incidence of splenic injury, and therefore, whenever possible, a laparoscopic technique should be used for splenic flexure mobilization. This advantage of laparoscopic surgery is related to the superior exposure, magnification and the use of fine instruments.

There are several tips and tricks which should be used to reduce the chance of splenic injury (Table 83.2).

1. Early division of the spleno-colic ligament and mobilization of the splenic flexure during any rectal, sigmoid, descending colon or transverse colon resection. Such mobilization, as the initial step of the planned operation, may prevent capsule tear caused by retraction of other segments of the colon while the splenic flexure is still attached to the spleen.
2. In case of adhesions from a previous procedure, time must be taken for careful and meticulous adhesiolysis around the spleen and the splenic flexure to regain anatomical orientation before mobilization of the colon is attempted. Even gentle retraction

Table 83.2 Tips and tricks for prevention of splenic injury during colorectal surgery

Early division of the splenocolic ligament and full mobilization of the splenic flexure
Meticulous adhesiolysis around the spleen and the splenic flexure
Dissection of the splenic flexure in two directions approach
Pushing with closed instrument rather than pulling the colon
Get the best available exposure (especially during open surgery, use appropriate retractors)
Consider hand-assisted laparoscopy in obese patients and in large bulky tumors

of such adhesions around the spleen or omentum adherent to the spleen, may result in capsular tear with significant bleeding.

3. The dissection of the splenic flexure is performed using two approach—lateral and from the distal transverse colon side. It is started laterally with division of the left white line and releasing the descending colon off the Gerota's fascia up to the spleen. The lesser sac is then entered by division of the gastro-colic omentum and the left transverse colon is mobilized all the way to the spleen. At this point, alternate dissection from both directions, medial to lateral and lateral to medial is gently performed. The dissection is done while downwards traction of the mesocolon with a closed instrument until both dissection planes are met and the spleno-colic ligament can be safely divided. Extra care is given to avoid thermal or mechanical injury of the colon at this stage. Further separation of the mesocolon from the tail and distal body of the pancreas completes the mobilization. Depending on the planned procedure, the division of the inferior mesenteric vein can be now easily carried out. Figure 83.4 shows a lateral approach in the mobilization of the splenic flexure and Fig. 83.5 shows a laparoscopic view after full mobilization of the splenic flexure.

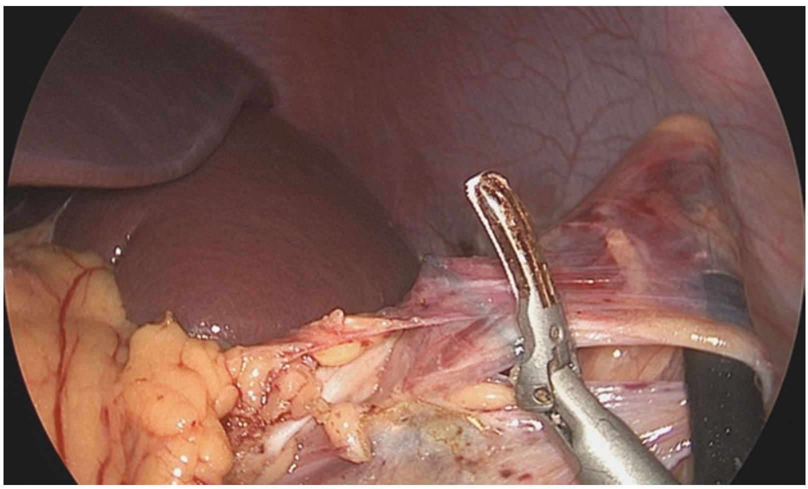

Fig. 83.4 Mobilization of the splenic flexure—lateral approach

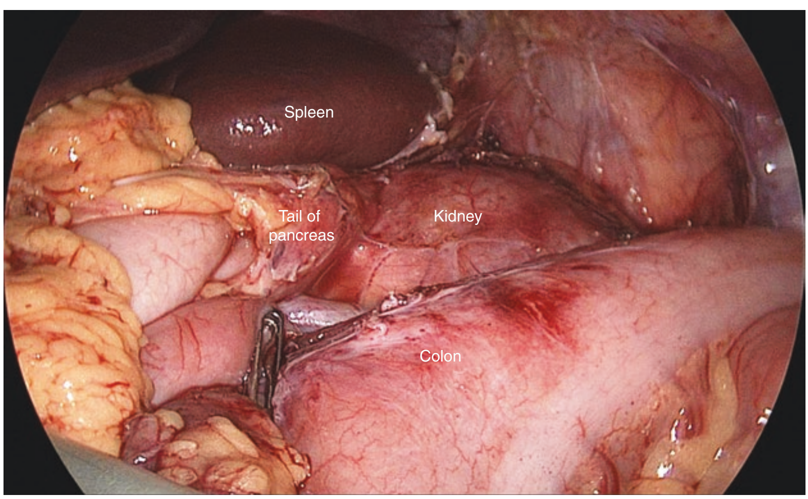

Fig. 83.5 Laparoscopic view after full mobilization of the splenic flexure

4. It is important to emphasize that during this entire maneuver, no direct grasping of the colon is used, as this may cause forceful pulling force on the spleno-colic ligament and results in capsular tear. Rather, a closed instrument, which is introduced through the lesser sac or between the descending colon and the Gerota's fascia, is used for pushing away the mesocolon of the flexure. Rarely, direct grasping of the mesocolon or appendix epiploica is used for traction to facilitate the dissection.
5. In open surgery, one of the major problems is limited exposure. This limitation can be resolved by using a headlight, as the regular operating room lighting is often insufficient. Another measure of exposure is extending the midline incision as high as needed or even extending the incision laterally sub-costal to enable good exposure of the left upper quadrant. Efficient retraction of the left rib cage is of utmost importance. Before starting the mobilization or ligament division, two wet lap pads should be placed behind and lateral to the spleen as this will medially rotate the spleen and will reduce the tension and shearing forces from the ligaments and its capsule. Care should be taken to remove them eventually.
6. During laparoscopic surgery, in addition to all the above considerations, we emphasize the importance of keeping anatomical orientation while using an angled scope to facilitate the dissection. General principles such as gentle tissue handling, trying to compensate for the loss of tactile sensation, accurate dissection and controlled traction and counter traction should be applied. Additionally, the "hidden" assistant—gravity, should be wisely used with frequent changes in table position to improve exposure and retraction.
7. Hand-assisted laparoscopy should be considered in severely obese patients and in patients with large tumors of the splenic flexure region, in patients who have severe multiple adhesions or as a bridge prior to full conversion.

E. Management of splenic injury during colorectal surgery:

Depending on the type and severity of injury, the management may vary from applying direct pressure, use of hemostatic materials, suturing, polar artery clipping, partial splenectomy to formal splenectomy.

In addition to the small risk of post splenectomy sepsis, incidental splenectomy in patients with colorectal cancer is associated with a worse prognosis independent of the stage of the disease.

Holubar et al., reported their experience with 68 patients operated for colorectal cancer who had incidental splenectomy and showed that splenectomy was associated with a significant decrease in survival at 5 years in patients with regional (Dukes' Stage C) disease but not in patients with localized (Dukes' Stage B) disease. Wakeman et al., performed a case-matched multicenter cohort study of 55 incidental splenectomies during colorectal operations and showed that overall morbidity and mortality were significantly higher in the splenectomy group.

Therefore, in any case of splenic injury, a salvage attempt should be made, whenever possible.

Figure 83.1 is a suggested stepwise, decision-making approach to the management of intra operative splenic injury.

A. The first step once splenic injury is encountered is to identify the exact source of the bleeding and the location of the capsule tear or parenchymal injury. In most cases, suction followed by local pressure using a 4 × 4 unfolded gauze which can be easily introduced through a 10 mm port, or in open surgery using a lap pad will achieve temporary bleeding control.
B. This control will allow for both the surgical and anesthesia teams to prepare for the next move. Two blood units should be brought and prepared standby for transfusion and additional IV lines are established as needed. An additional port for a second suction device or retractor is commonly needed and alertness of the entire team is achieved.

Fig. 83.6 Control of splenic laceration with hemostatic agent

C. The next maneuver, depending on the size of laceration and the amount of bleeding is the use of hemostatic agent followed by resuming local pressure for several minutes (Fig. 83.6). In many instances, this will be sufficient.
D. If more oozing or continues bleeding is seen, the use of an Argon Beam Coagulator may be very useful, using an open or laparoscopic probe and is easily operated. If bleeding is controlled, the gauze or pad is left on the site while the rest of the operation is continued. Occasionally, further dissection and complete mobilization of the splenic flexure is required for full exposure of the splenic injury and only then hemostasis can be achieved.
E. If the lower pole is lacerated, quick dissection, exposure and clipping of the polar artery should be undertaken, even though this maneuver usually results in infarction of the lower pole of the spleen which is of little or no consequences. Blocking the arterial blood flow to the lower pole will decrease the amount of bleeding and may increase the efficacy of the above-mentioned hemostatic actions.
F. If bleeding continues, partial splenectomy of the lower pole, if feasible, may be considered in selected cases such as young patients in whom easy access to the splenic hilum can be achieved.
G. If the splenic injury consists of deep parenchymal laceration inadvertently caused by a surgical instrument, packing with hemostatic material alone or with hemostatic suturing with pledgets may be used. Such suturing should be carefully conducted, without excessive tension, to avoid further lacerations of the splenic parenchyma.
H. Splenic injury at the level of the hilum or lacerations of the main splenic vessels will commonly require splenectomy. Nonetheless, if vascular injury is encountered, clipping of a main splenic vessel while the short gastric vessels are intact may allow keeping the spleen in place with close post-operative observation, to exclude splenic abscess formation. The threshold for splenectomy should be low in hemodynamically unstable patients, older age patients, large or deep lacerations or when bleeding was encountered in additional regions of dissection like the retroperitoneum or pelvis.
I. Based on the surgeon's experience, preference—and depending on the amount of bleeding and the patient's condition—laparoscopic splenectomy or conversion to open surgery is performed.

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84 Colonoscopic Complications: Colonic Perforations

Andrew T. Strong and Jeffrey L. Ponsky

Refer to Algorithm in Fig. 84.1

A. Colonoscopy is one of the most frequently performed medical procedures. Its use is predicated upon the ability to diagnose diseases of the colon and identify premalignant lesions by visual inspection. In addition, such lesions can most often be excised or destroyed to prevent progression to malignancy. While the procedure has become routine throughout the world, complications continue to occur. Iatrogenic perforation is both the most frequent and serious of major complications. Recent estimates from large multicenter trials and databases estimate perforation to occur in 0.015–0.24% of all colonoscopies. Perforation rates increase to near 0.1% when restricted to only colonoscopies that include therapeutic interventions. The procedure most likely to produce a perforation is endoscopic submucosal dissection (ESD), with rates around 5%. While early studies estimated mortality up to 5% with iatrogenic perforations, that number has decreased to less than 1 in 1000 in more recent larger studies.

Prior to discussing management of iatrogenic colonic perforations it is important to have a conceptual framework of the etiologic mechanisms related to colonoscopy that lead to such perforations, as this can inform the appropriate options for management. Perforation may result from a variety of injury mechanisms that may occur during colonoscopy. Some of these mechanisms are common to any colonoscopy, whether undertaken for diagnostic or therapeutic intent, others are specific to therapeutic techniques and devices. Errors in technique that can lead to perforation with any colonoscopy included barotrauma, direct trauma from the scope tip, blind advancement, and bowing or looping. Inadequate bowel preparation can provide a more injury-prone environment. Devices used for hemostasis, biopsy and polypectomy can lead to tissue trauma and add additional risk of perforation. Recent advances in techniques of endoscopic resection have pushed the frontier of the size and type of lesions that can be endoscopically addressed, including endoscopic mucosal resection (EMR), endoscopic submucosal dissection (ESD) and submucosal tunneling; however larger areas of resection are associated with larger areas of weakness and greater rates of perforation. Perforation management is

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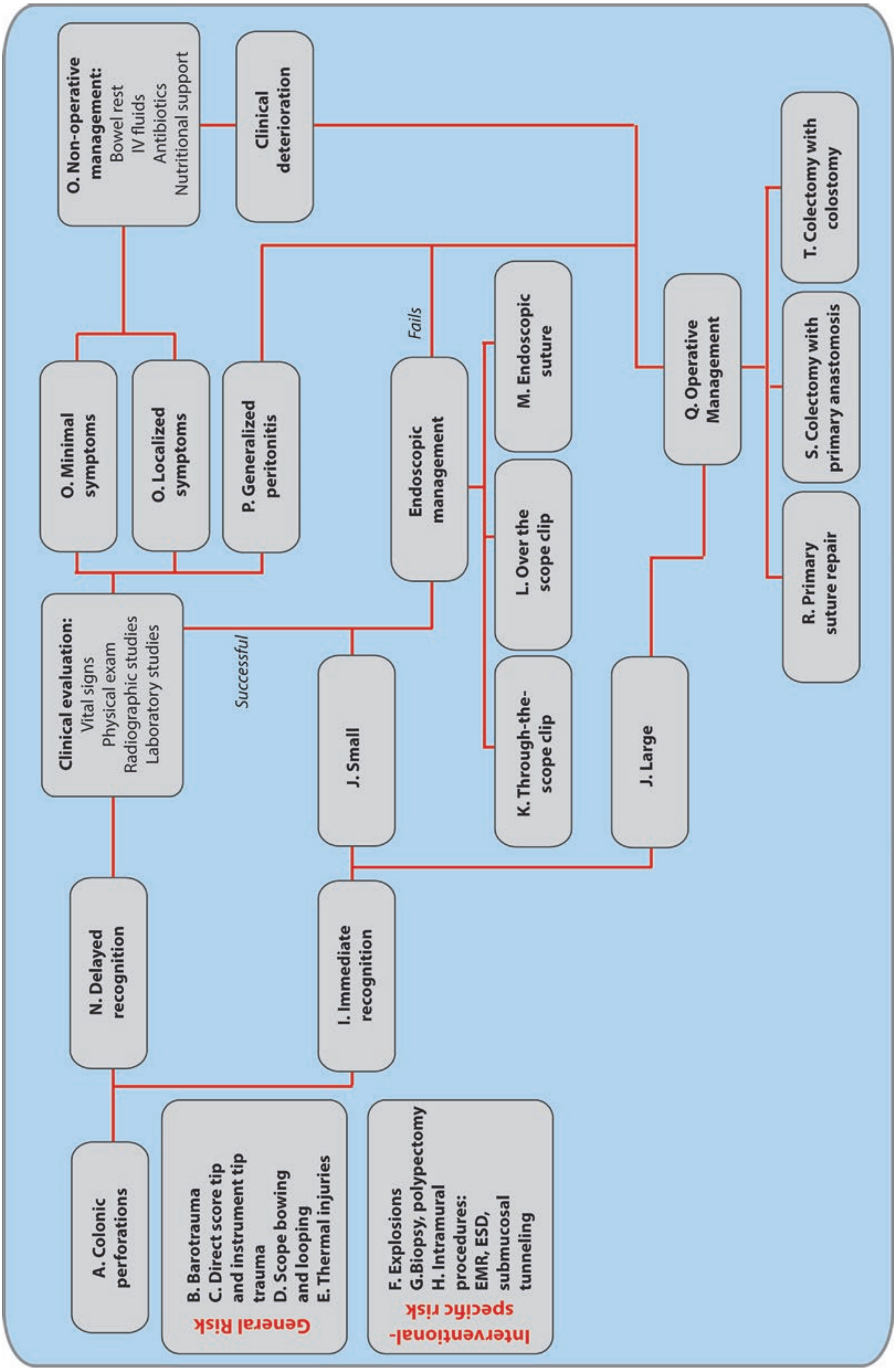

Fig. 84.1 Algorithm for colonic perforations. *EMR* endoscopic mucosal resection, *ESD* endoscopic submucosal dissection

based on patient condition, time of recognition, and extent of injury (see Fig. 84.1).

B. Iatrogenic perforation due to barotrauma results from aggressive insufflation. Thankfully, barotrauma is easily preventable by both minimizing insufflation, and/or use of carbon dioxide insufflation. Conditions predisposing to barotrauma include prolonged procedures, poor bowel preparation, strictures, or obstructing lesions. In cases where multiple strictures are present, gas can become trapped between the narrowed areas and quickly lead to over distension and perforation. Barotrauma related perforations are often large and are difficult to endoscopically manage.

C. Perforations due to pressure from the endoscope tip may occur when the scope inadvertently enters a diverticulum, or is blindly advanced against the colonic wall. These perforations tend to be small, often smaller than the scope diameter. Maintaining a view of lumen should prevent this type of injury.

D. Scope looping and bowing can introduce longitudinal injuries to the colonic wall. While most injuries of this type only affect the mucosa, aggressive maneuvering can lead to transmural injuries. Tears that result tend to be large linear tears, and most often occur in the sigmoid secondary where the scope is also most likely to form loops. Longitudinal tears are generally difficult to endoscopically close and best dealt with surgically. Early surgical intervention, when indicated, will often permit primary repair of the colon.

E. Thermal injuries can occur by means of several different therapeutic technologies available for use through the colonoscope. Electrocautery used for hemostasis or resection can be monopolar electrocautery, hot biopsy forceps, hot snares or bipolar coagulators. These devices utilize electrical current applied to a resistive metal tip to generate heat. The endoscopist must recall that that the instrument remains hot, and capable of tissue injury, even after the current is turned off. Thermal energy spread, and as such, thermal tissue damage spreads radially from the instrument tip and can cause thermal injury over a much broader area than intended. It is not uncommon for these injuries to create large perforations with a delayed presentation. Argon plasma coagulation (APC) is used primarily for hemostasis. Hot plasma generated from argon gas provides a narrowly targeted area of high temperature. However, the concentrated high temperature can easily cause thermal injury to deeper levels of tissue. In addition to thermal injury, these when the tip of electrocautery or APC devices is allowed direct tissue contact the destroyed tissue can coagulate around the tip of the device, which when freed can lead to traction injuries.

F. An extreme example of thermal injury relates to inadequate preparation. Prior to colonoscopy, typically colonic contents are purged with laxatives, cathartics or osmotic agents. Underappreciated is the fact that colon preparation evacuates not only solid components, but also explosive methane and hydrogen gases produced by colonic bacterial flora from ingested fermentable compounds. If these gases are not adequately evacuated prior to the introduction of electrocautery or APC, the thermal energy is sufficient to cause ignition of these gases and resultant explosion. When inadequate preparation is noted during the examination, no attempt to utilized electrosurgical instruments should be entertained. Therapeutic maneuvers requiring cautery should be re-scheduled after adequate preparation. Thankfully, such occurrences are extremely rare, and there are only nine cases reported in the literature. Explosions and perforations that result from gas explosions can cause tremendous damage to the colon and other organs and should be managed rapidly in the operating room.

G. Many perforations are related to the combination of devices used for biopsies and polypectomy. Cold forceps and cold snares are appropriate to use for mucosal biopsies and for polyps under 1 cm, and infrequently lead to perforations. Hot forceps and snares are used for removal of larger polyps. There con-

tinues to be debate about which mode of current delivery (blend vs pure coagulate) is safer in terms of achieving adequate hemostasis and lower perforation risk. Post polypectomy syndrome describes transmural thermal injury that presents in a delayed manner after use of electrosurgical devices for polypectomy. Apart from thermal injury, perforations can result from excessive amounts of tissue being bunched into snares. The majority of perforations related to polypectomy occur in the cecum and ascending colon, presumed to be due to a thinner colonic wall.

H. EMR has been widely adopted to accomplish endoscopic resection of larger polyps. In EMR, saline or other fluids are injected into the colonic wall to provide a fluid cushion between the mucosa and deeper layers of the colon wall, followed by resection with a snare. This is particularly useful for sessile polyps. For lesions larger than 2 cm, a piecemeal resection is recommended to reduce the risk of perforation. ESD similarly begins with fluid elevation, but resection is accomplished by circumferential and deep dissection with a needle knife instrument in the submucosal plane. While this allows for complete resection of larger polyps, it leaves a large area of mural weakness. Recently, submucosal tunneling and dissection has been adapted to facilitate resection of intramural tumors of the colon. While both EMR and ESD confer additional risk of perforation, these perforations tend to be smaller than perforations that occur during diagnostic colonoscopies because they most often occur from injury with the small electrosurgical knives, which are typically 1–3 mm in diameter. Because of their small size, perforations occurring during ESD and EMR may be better amenable to endoscopic management.

I. Management of iatrogenic perforations is first dependent on recognition of an injury. In some cases perforations are obvious on endoscopy. Severe abdominal pain, hemodynamic changes and difficulty maintain colonic insufflation suggest the presence of a perforation during the procedure. Minimizing insufflation and/or switching to carbon dioxide insufflation at that point is prudent. Unfortunately, only around 25% of perforations are recognized at the time of colonoscopy. When noted at the time of colonoscopy, endoscopic techniques are available to attempt management for some perforations. The majority of lesions that either elude detection during colonoscopy, are recognized within 24 hours (~75%) of colonoscopy. The balance presenting by 96 hours (4 days) after the procedure with rare exceptions up to 2 weeks. Management of these perforations is typically not endoscopically pursued, and is dependent on the patient's clinical picture, symptoms and size of the perforation.

J. When perforation is recognized during the procedure, the endoscopist must assess the extent of injury and consider the modalities available to endoscopically address the perforation as well as comfort and skill to do so. Any time fat or muscle fibers are seen, a perforation likely exists. Some describe a "target sign" where the rings are comprised of the interfaces between the mucosa and submucosa and then the submucosa and muscularis propria, which may also include fat. This sign indicates that perforation is at least impending, if not already occurred. Typically lesions less than 1–2 cm in size are amenable to endoscopic management, with techniques discussed below. Large perforations and longitudinal injuries are best managed surgically. Two cautionary caveats to attempting endoscopic management should be noted. First, spillage of even modest amount of luminal contents should prompt surgical consultation. Secondly, the edges of the perforation must be free from other pathologies. Attempting to re-approximate tissue edges that themselves have thermal damage, are fibrotic or carry the possibility of residual malignancy are ill-suited to endoscopic management and better managed surgically, even when small. Rapid involvement of a surgical team in these circumstances

limits spillage of intraluminal contents and bacterial migration, thus increases the likelihood primary suture repair can be accomplished. Failure of endoscopic management should prompt surgical repair.

Successful endoscopic management is predicated on the availability of the appropriate endoscopic instruments, and the comfort of the endoscopist in using them. Generally, three modalities present themselves as options, and they can be used alone or in combination. These modalities are through the scope clips, over the scope clips and endoscopic suturing. The latter two require removal of the endoscope for device assembly. Re-identification of the perforation is not always possible, especially if the perforations are within areas of natural flexion within the colon. Marking with tattoos or through the scope clips can be useful.

When endoscopic modalities are employed, effective closure of the perforation is often possible. However, patients should continue to be observed, including frequent assessment by physical exam and/or radiography. An antibiotic to cover enteric bacteria, including anaerobes, is generally indicated. Progression to peritonitis, or any sign of clinical deterioration should lead quickly to surgical exploration and repair.

K. Deployable metallic clips delivered through the working channel of the endoscope are a popular option (see Fig. 84.2c). In the absence of comparative study of through the scope clips, selection should be based on availability and the preference of the endoscopist. Clips can be sequentially deployed and are best suited to more linear lesions. When multiple clips are used, they should be placed close together to avoid small gaps and dog ears where tissue is less effectively approximated. Techniques to aid in successful closure include the use of a scope cap to better approximate tissue edges prior to clip application, and working from left to right and top to bottom if possible.

Several manufacturers produce through the scope clips, each with subtle variations in the width of jaw opening, ability to rotate, and retention time in the tissue. Some of the

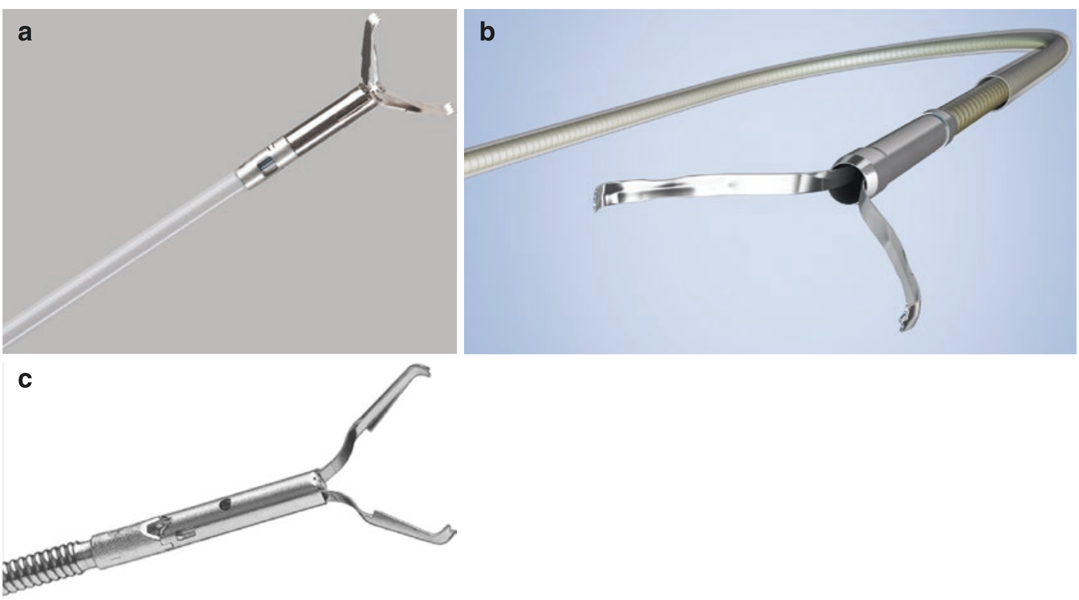

Fig. 84.2 (**a**) Instinct™ (Permission for use granted by Cook Medical, Bloomington, Indiana) through the scope clip; (**b**) QuickClipPro™ (Olympus America, Center Valley, PA) through the scope clip. Reused with permission from Olympus; (**c**) Resolution™ (Boston Scientific, Boston, MA) through the scope clip. (Images provided courtesy of Boston Scientific Corporation)

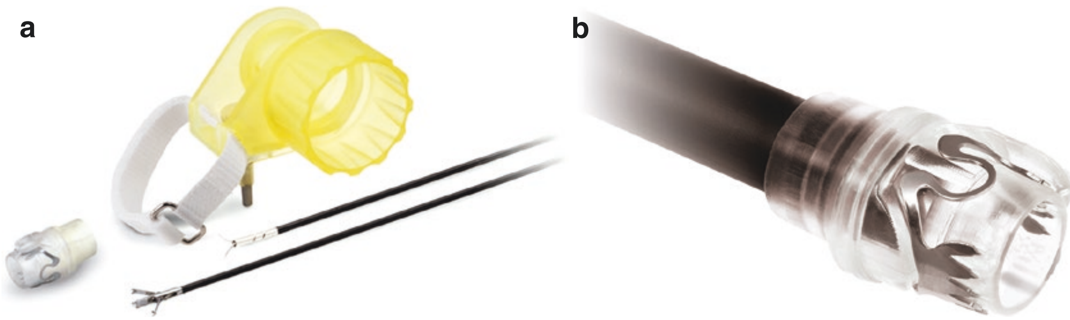

Fig. 84.3 (**a**) Components to assemble and deploy OTSC® clip (Ovesco Endoscopy USA Inc., Cary, NC); (**b**) Deployed OTSC® clips (Ovesco Endoscopy USA Inc., Cary, NC)

commercially available devices in the United States include Instinct™ (Cook Medical, Bloomington, IN) (Fig. 84.2a), QuickClip2™ (Olympus America, Center Valley, PA), QuickClipPro™ (Olympus America, Center Valley, PA) (Fig. 84.2b), and Resolution™ (Boston Scientific, Boston, MA) (Fig. 84.2c).

L. Over the scope clips, also known as bear claw clips, resemble the jaws of a bear trap (see Fig. 84.3a). They are deployed from a clear cap applied to the tip of the endoscope, controlled by a string that must be fed through the working port. A grasper can be used as an aid to tissue positioning prior to clip deployment. Larger lesions can be successfully managed with over the scope clips, but serial deployment is difficult. It is important to reiterate that, as opposed to through the scope clips, over the scope clip requires removal of the endoscope for device assembly. This increased risk of injury on re-introduction, and also runs the risk of being unable to locate the perforation at repeat endoscopy. Currently there is only one clip of this type available in the United States, OTSC® (Ovesco Endoscopy USA Inc., Cary, NC). Figure 84.3a demonstrates the various components of the OTSC® system. Figure 84.3b is a magnified image of the two of the clips in their deployed state. Note that the shape of the teeth differs, and shapes are specialized for specific uses and applications.

M. Endoscopic suturing is a third technique for endoscopic management, but probably requires the greatest technical ability to successfully utilize. There is only one commercially available device in the United States, the OverStitch™ (Apollo Endosurgery, Austin, TX). The OverStitch™ has multiple components utilized through a dual channel endoscope, including a portion that must be applied to the tip of the scope. A retrievable curved needle places a suture with the assistance of an auger-like device to stabilize the tissue. The suture is secured by T-fasteners at either end. The greatest advantage of endoscopic suturing is the ability to approximate irregular edges or larger lesions. The two major disadvantages are the need to remove and reinsert the colonoscope to assemble the device, and the high degree of technical acumen needed to master this intervention.

N. The presence of hemodynamic instability, high fever, and/or generalized peritonitis typically obliges surgical exploration. If the patient is hemodynamically stable and has minimal or only focal symptoms, an abdominal plain film is a useful adjunct, as long as it includes a lateral decubitus or upright film.

O. Patients with minimal symptoms generally have very small perforations with no spillage of colon contents and quickly seal. Focal peritonitis suggests a larger perforation, contained by the omentum and the surrounding abdominal structures. Non-operative management is appropriate for these patients, and often successful. Non-operative management includes bowel rest, intravenous fluid resus-

citation and antibiotics that will cover potentially pathogenic colonic flora, including anaerobes. While nutritional support with intravenous nutrition may be helpful, symptoms generally resolve or patients warrant surgical intervention prior to this being indicated. However, most patients were calorie deprived for 1–2 days prior to colonoscopy due to colon preparation, so earlier implementation of intravenous nutrition can be entertained. Frequent reassessment with physical exam, and/or abdominal X-ray is essential if non-operative management is pursued. Any evidence of clinical deterioration, or more extensive peritonitis should prompt surgical exploration.

P. Generalized peritonitis or large pneumoperitoneum on abdominal plain film generally warrants operative exploration. These findings suggest large perforations and/or large amount of spillage of intraluminal contents. Source control is the primary objective to limit abdominal sepsis and associated morbidity and mortality.

Q. When operative intervention is indicated, laparoscopic exploration is possible, and the presumed mechanism of perforation may aid in the decision in operative approach. Here discussion between the endoscopist and surgeon, if different providers, is beneficial. Small perforations that result from polypectomy, ESD or EMR can often be laparoscopically managed. If laparoscopic management is to be attempted a rectal tube can aid in reducing colonic distension and increase working space. Large perforations, multifocal injuries, unclear location of injuries, or significant spillage may be better addressed with exploratory laparotomy. Once perforations are identified, size, location, the condition of the tissue and contamination aid in determining appropriate methods to address the perforation. Thankfully, colonic prep generally limits luminal spillage, and resultant complications.

R. Small perforations, which are the most common, can often be repaired primarily with suture. The edges of the wound should be debrided to healthy tissue. Closure can be completed in single or double layer. With this technique, care should be taken not to significantly narrow the lumen.

S. Colectomy with anastomosis is appropriate if there is minimal contamination

Larger injuries that are associated with minimal contamination can be treated with segmental resection and primary anastomosis. Anastomotic technique should be dictated by the location of the perforation.

T. Excessive contamination, ischemic colonic segments, large injuries or operative delay may necessitate colectomy with an ostomy.

Colonoscopy has been and continues to be an outstanding asset in the diagnosis and therapy of colonic disease. Endoscopists and surgeons must be cognizant of the proper preparation for and conduct of the procedure and be prepared to recognize and treat its complications when they occur.

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85 Complications: Early Anastomotic Complications—Leak, Abscess, and Bleeding

Vahagn C. Nikolian and Scott E. Regenbogen

Intra-abdominal Anastomotic Leak

Refer to Algorithm in Fig. 85.1

A. A high index of suspicion is necessary when evaluating patients following creation of a colorectal anastomosis. Anastomotic leak occurs in 2–19% of patients, depending on the location of the anastomosis. Operative factors such as intestinal blood supply, tension at the anastomosis, and prolonged operative duration can increase the risk for developing anastomotic complications. In addition, patient and disease factors such as elevated body mass index, old age, tobacco use history, inflammatory bowel disease, cancer stage, preoperative radiotherapy, and immunosuppression increase the risk of developing post-operative complications. Major leaks are more easily identified as they present with classic signs including generalized peritonitis or septic physiology. However, soft signs such as a low-grade fever or a prolonged post-operative ileus may be the only clinical manifestations of more insidious leaks. Research related to improved detection and earlier interventions to reduce the morbidity associated with leaks is ongoing. Some groups now advocate the use of standardized post-operative surveillance protocols to more effectively diagnosis and treat anastomotic leaks. Others are targeting biomarkers that may identify leaks. Serum cytokines, lipopolysaccharides, and C-reactive protein have been reported to potentially help identify patients with post-operative complications.

B. Management strategies for pelvic anastomoses (e.g. extraperitoneal anastomoses) will be discussed in Fig. 85.2. Key differences are present when evaluating patients with pelvic leaks. Given the lack of an innervated peritoneal surface, patients suffering from pelvic leaks will often not develop peritoneal signs which are common in the setting of intra-abdominal anastomotic leaks. However, if a localized abscess is to rupture into the peritoneal cavity, generalized abdominal pain may develop.

C. Patients may present with subclinical leaks. Subclinical leaks may be identified on studies evaluating the anastomosis (*i.e.,* when planning for the reversal of a proximal diverting ostomy) or by the presence of enteric contents in a drain. In these patients who do not have any clinical evidence of leak, management can be performed in an expectant manner. If the fluid collection is accessible, it may be

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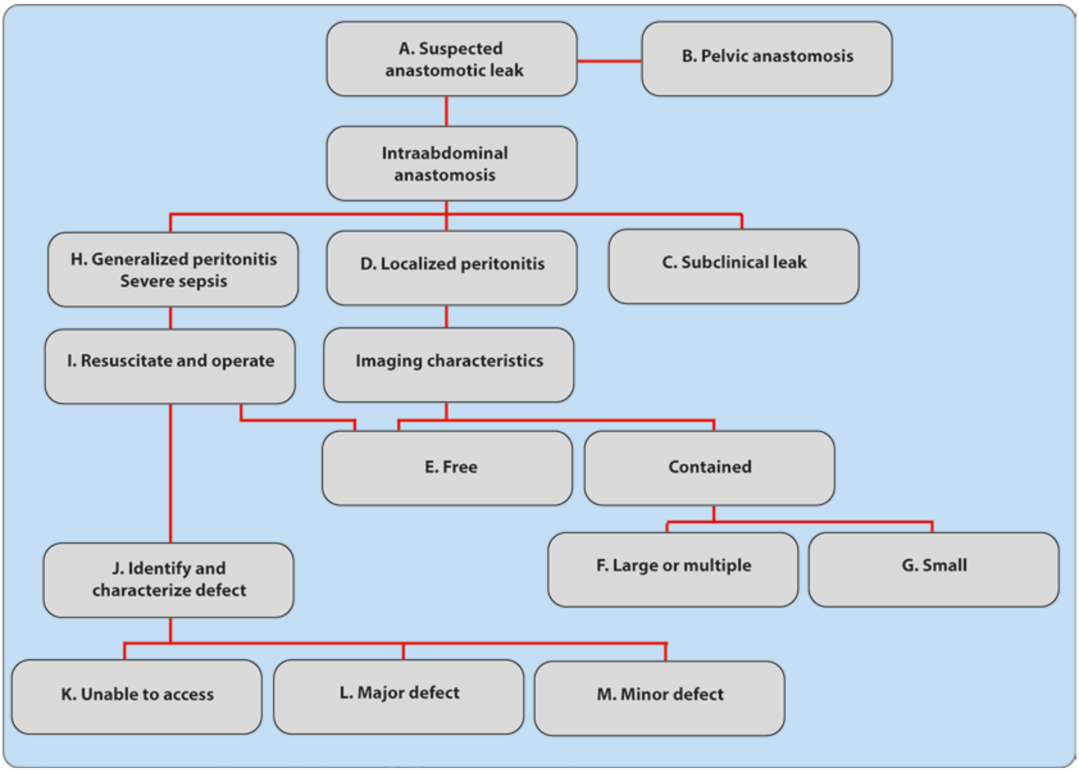

Fig. 85.1 Algorithm for management of intra-abdominal anastomotic leaks. Adapted from Phitayakorn et al.

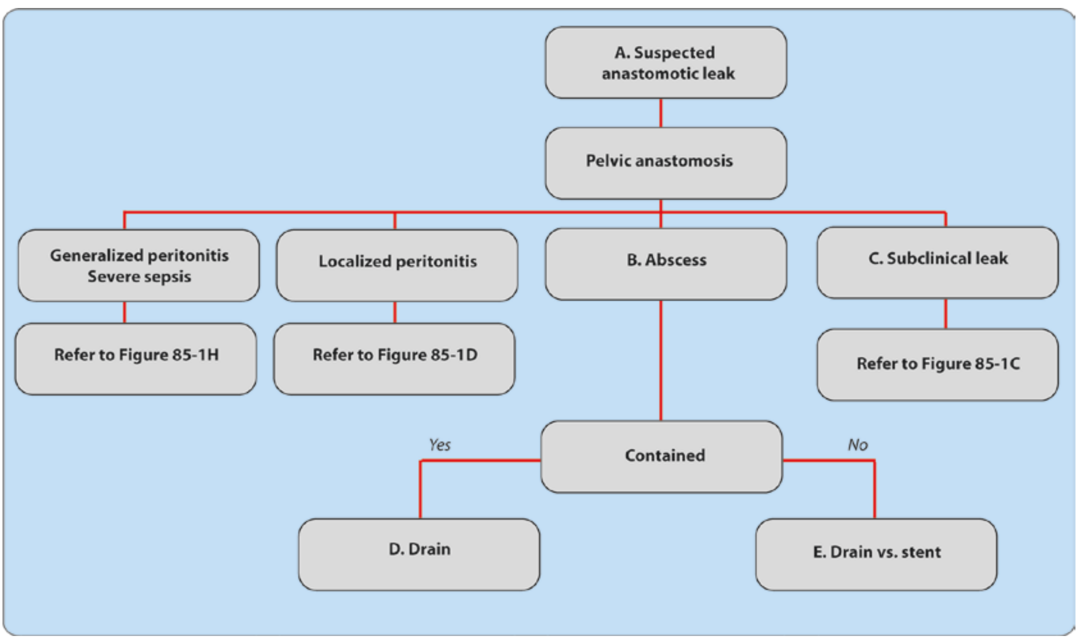

Fig. 85.2 Algorithm for management of pelvic anastomotic leaks. Adapted from Phitayakorn et al.

worthwhile to percutaneously drain and initiate a short course of antibiotics. Interval imaging after 6–8 weeks is performed to evaluate if the leak has resolved. This cycle of antibiotics and imaging can continue for months, with most subclinical leaks eventually resolving and allowing for a safe second stage operation to reverse the proximal stoma. In the event of a persistent leak, the second stage operation will require revision of the anastomosis.

D. Oftentimes, patients will present with nonspecific findings such as localized peritonitis. In the correct clinical setting, this may imply an anastomotic leak. So long as a patient's clinical status is stable, further evaluation with imaging studies should be performed. When performing these studies, a thoughtful approach and clear communication with the radiologist can make a significant impact. When assessing an anastomosis, the most sensitive study to identify a leak is considered a CT scan with oral, intravenous (IV), and rectal contrast (Fig. 85.3). If coordinated appropriately, cross-sectional imaging can serve as a diagnostic and therapeutic strategy, potentially identifying leaks that are amenable to drainage or aspiration. Though not as sensitive for identifying leaks, water-soluble contrast enemas can also be performed.

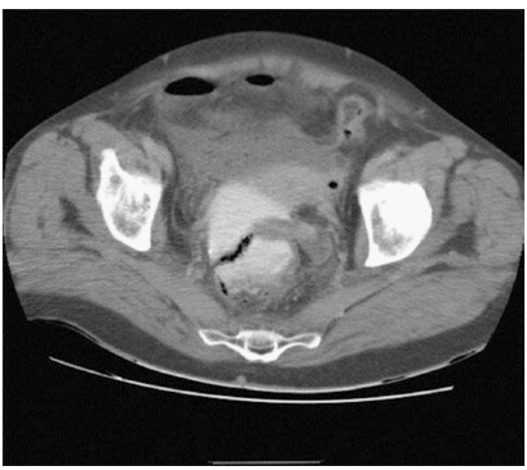

Fig. 85.3 CT scan to detect leak

E. In patients with localized peritonitis and stable vital signs, it's unlikely that a free intra-abdominal leak is identified on imaging. However, if such a situation is encountered, management strategies should focus on a similar approach as described for patients with severe leaks (Fig. 85.1, **Sect. K**). Management strategies for patients presenting with contained leaks are related to the complexity of the fluid collections.

F. For contained leaks larger than 3 cm, that contain multiple abscesses, or have imaging characteristics of a multi-loculated collection, the clinical condition of the patient will guide management. Percutaneous drainage may be used to manage many of these findings. Operative intervention should be sought for patients who have large burdens of infection, abscesses in inaccessible anatomic sites, or have persistent sepsis or deteriorating clinical status. Preoperative evaluation of the anastomosis with water-soluble contrast enema or CT scans with 3D reformatting can help to develop an operative plan—minimizing manipulation of a potentially salvageable anastomosis. However, if these studies are not available or difficult to interpret, careful intraoperative assessment of the anastomosis is still possible. At the time of laparotomy, the anastomosis is especially fragile secondary to local inflammation and infection. The viability of the anastomosis can be assessed in a variety of ways if it is unclear whether or not it is intact. Air-leak tests, instillation of intraluminal fluids (i.e., methylene blue with saline), or concurrent endoscopic evaluation can help determine if the anastomosis is perfused, and if it is amenable to repair and salvage.

G. For small, contained abscesses measuring less than 3 cm, broad-spectrum antibiotics should be initiated and source control obtained via percutaneous drainage, if possible. If the cavity is large enough, a drain should be left in place to allow for further drainage. Some have advocated the use of saline irrigation and fibrinolytic agents to maintain patency and improve drainage. In

the event that the cavity cannot be accessed, broad-spectrum antibiotics will be adequate for the majority of patients.

H. Anastomotic complications that present with generalized peritonitis or severe sepsis require urgent interventions, as delay can contribute to morbidity and mortality. In addition, any patient who is managed conservatively with non-operative measures and fails to improve will require surgical intervention.

I. For patients who are critically ill, standardized guidelines for the management of sepsis should be followed. Initial resuscitation to restore tissue perfusion is imperative. Measuring biomarkers, obtaining blood cultures, initiating broad spectrum antibiotics and administering fluids should be done expediently. If the patient does not respond to initial fluid administration and is persistently hypotensive, vasopressors should be applied to maintain a mean arterial pressure greater than 65 mmHg. Upon completing these bundles of care, operative management for the anastomotic leak is necessary for source control.

J. No true consensus has been established for defining the severity of anastomotic leaks preoperatively. The International Anastomotic Leak Study group has identified major leaks both anatomically (i.e., defects greater than 1 cm or greater than one-third the circumference of the anastomosis) and clinically (i.e., severity of sepsis, physical examination findings). Intraoperatively, a variety of situations may be encountered and are discussed below. For any patient undergoing a laparotomy, a decision must be made regarding the original anastomosis. The options include resection of the anastomosis with formation of an end stoma and Hartmann's type distal closure, exteriorization of both ends of the anastomosis, resection and repeat anastomosis with proximal diversion, primary repair of the anastomosis with or without proximal diversion, and proximal diversion alone. Irrespective of procedure, the goal is for source control. Decisions regarding the use of drains should err on the side of caution, with a low threshold to have wide drainage (at least initially). In cases where there is severe soiling of the abdominal cavity, damage control techniques such as open management with delayed abdominal closure may be considered, allowing for reevaluation of the abdomen when the patient's physiologic parameters are more favorable for a prolonged operation. Patients should be advised that regardless of the final outcome related to diverting stomas, future operations for the sake of reestablishing gastrointestinal continuity will nearly always be delayed 3–6 months to allow resolution of acute inflammatory adhesions and reduce the risk of operative complications.

K. At times, inflammation and adhesions preclude a safe evaluation of the anastomosis. Further dissection in the area of interest may convert a minor leak into a major one. In these scenarios, damage control measures should be undertaken. Thorough irrigation and drain placement can help decrease the burden of infection. Next, identification of the proximal segment of bowel can allow for diversion upstream of the anastomosis. If the proximal bowel is mobilized, a looped ostomy will allow for the safest operation. Unfortunately, these cases often present with significant inflammation of the bowel near the anastomosis. As such, diversion may require the utilization of proximal ileum or jejunum, making the post-operative management even more challenging, as many patients can require supplemental nutrition via parenteral access.

L. Major anastomotic defects have large infectious burdens. In addition, the viability of the bowel near the anastomosis is typically poor. In these situations, resection of the anastomosis with end stoma formation may be necessary. If there is adequate mobilization and length to the distal bowel segment, some advocate exteriorizing both ends of bowel to reduce potential complications related to a distal stump blowout. A surgeon should exercise caution if considering the formation

of a new anastomosis. In these cases, the benefits of a simplified second stage operation to reestablish gastrointestinal continuity must be weighed against the potential for another anastomotic leak. As such, this intervention should be avoided in patients with physiologic evidence of severe sepsis or underlying risk factors that contributed to their first leak.

M. Management strategies for minor leaks (i.e., size less than 1 cm or encompassing less than one-third of the anastomotic circumference) are based on the patient's clinical status and the quality of the tissues at the original anastomosis. If the tissues at the area of anastomotic dehiscence are of good quality, a primary repair may be attempted. Generally, it is advisable to leave drains near the anastomosis and perform a proximal diversion with a loop ostomy. If the tissues are not of good quality, then management strategies are similar to those described for major leaks (Fig. 85.1, **Sect. L**).

Pelvic Anastomotic Leaks

Refer to Algorithm in Fig. 85.2

A. Anastomotic leaks within the pelvis are managed with many of the same principles as those for patients with intra-abdominal leaks. However, low rectal anastomoses may pose additional anatomic challenges, as there may be cases in which it is not possible to safely resect, repair, or revise a pelvic anastomosis. Patients presenting with generalized peritonitis and signs of sepsis will require an emergent operation, but upstream diversion may be the only viable intervention (Fig. 85.1, **Sect. H**). When resecting the anastomosis, one may encounter a very inflamed and friable distal rectal stump which is impossible to suture or staple closed. In these scenarios, one should irrigate the pelvis and rectum and leave pelvic and transanal drains. Patients presenting with localized peritonitis will require similar management approaches as described for patients with intra-abdominal anastomoses (Fig. 85.1, **Sect. D**). Cross sectional imaging with CT scans with IV and rectal contrast will help delineate the location of fluid collections and determine if it communicates with the lumen, respectively. Given the friable nature of the anastomosis, rectal contrast should be administered by a member of the surgical team or an experienced radiologist. Soft rubber catheters and careful instillation of contrast can reduce the chance of further disrupting the anastomosis. Endoscopic or proctoscopic evaluation can be pursued to further identify the location of the anastomotic dehiscence.

B. As mentioned before, pelvic anastomotic leaks may present differently than intra-abdominal leaks secondary to a lack of a large, exposed peritoneal surface. In addition, low rectal anastomoses are often protected by a diverting ileostomy, making the clinical presentation sometimes more subtle. Paying attention to subtle signs such as tachycardia, oliguria, prolonged post-operative ileus, or changes in mental status may be the first clues that a patient is suffering from pelvic sepsis. If not identified early in the course of infection, pelvic abscesses may increase in size and rupture into the abdomen (causing peritonitis) or drain into the intestinal lumen (providing source control for the infection in some cases).

C. For high rectal abscesses near the peritoneal reflection, one should proceed with a similar management strategy as described for leaks encountered in the abdomen (Fig. 85.1, **Sect. D**).

D. Low pelvic abscesses identified on cross-sectional imaging are characterized by their anatomic location relative to the rectum (anterior vs. posterior) and whether or not they communicate with the lumen. These leaks more often present posteriorly, which is fortunate as anterior leaks can be more treacherous to treat because of proximity to surrounding organs. Antibiotics are used in most patients, usually in combination with other techniques for larger fluid collections. Abscess that are not in continuity with the

lumen can be managed via percutaneous, transrectal, transanal, or transvaginal approaches with a low risk of developing a fistula. In certain cases, the abscess is unable to be accessed via these first-line approaches and alternatives such as transgluteal drains must be utilized. Pain from sciatic nerve inflammation and spread of infection into the gluteal region have been described. For low-lying anastomoses, examination under anesthesia can provide another option for transrectal drainage. During proctoscopy, a mushroom tipped catheter can be placed within the abscess cavity and sutured externally. This allows for continuous drainage of the cavity as well as access for fluoroscopic evaluation during follow up.

E. For abscesses that are in continuity with the lumen, drainage can be performed through the site of dehiscence to reduce the potential for fistula formation. Enlarging the dehiscence bluntly with a finger or instrument can be performed. Again, utilizing catheters to maintain patency of the communication and allow for drainage of the cavity is recommended. Once the cavity has drained and regressed in size, the catheter can be removed to allow for the anastomosis to heal. The use of endoscopically placed covered stents have recently been described but are not commonly employed. A key element to this strategy is percutaneous drainage of the cavity. The stents are known to migrate and are even expelled by the patient prompting some to use endoclips to better secure the stent following deployment.

Anastomotic Bleeding

Refer to Algorithm in Fig. 85.4

Bleeding from the anastomosis can have a wide spectrum of presentations and should be managed in a similar manner to lower gastrointestinal bleeding that presents from other causes. Minor bleeds are relatively common, yet rarely reported as a complication. They are identified by the passage of blood for the first few bowel movements following operation. For the majority of patients, minor bleeding is a self-limited problem that requires no intervention. However, some patients may progress to a major bleed which result in hemodynamic instability, the need for blood transfusion, or necessitate a procedure to obtain hemostasis. These bleeds typically originate from a trapped mesenteric vessel within the anastomosis or a perforating vessel near the anastomosis. Given the etiology, some advocate the use of endoscopic evaluation during initial operation to ensure anastomotic hemostasis. As with all cases of bleeding, coordination of care is imperative. Adequate intravenous access and blood component resuscitation is necessary. Following initial resuscitation of the patient, hemodynamic stability should be assessed to guide the next steps in management.

It is rare for anastomotic bleeding to result in shock. However, if resuscitation attempts do not normalize the patient's hemodynamic status, emergent endoscopy and/or abdominal exploration should be performed. During the operation, one should work to quickly identify the anastomosis, evaluate for bleeding, and either over-sew a bleeding vessel or resecting the previous anastomosis. If the patient is stable, a new anastomosis may be created at this time. If not, the patient may require an end ostomy and have a second stage operation for reestablishing gastrointestinal continuity.

The majority of patients requiring intervention for an anastomotic bleed can be managed endoscopically. Techniques including washout using saline, electrocoagulation, injection of epinephrine, and clipping of bleeding vessels have all been successfully utilized to obtain hemostasis. If visualization of the lumen is challenging secondary to clot burden, it may be necessary to convert to laparotomy or obtain angiographic evaluation with subsequent embolization of the bleeding vessel. The latter approach should be exercised with caution as it can place the anasto-

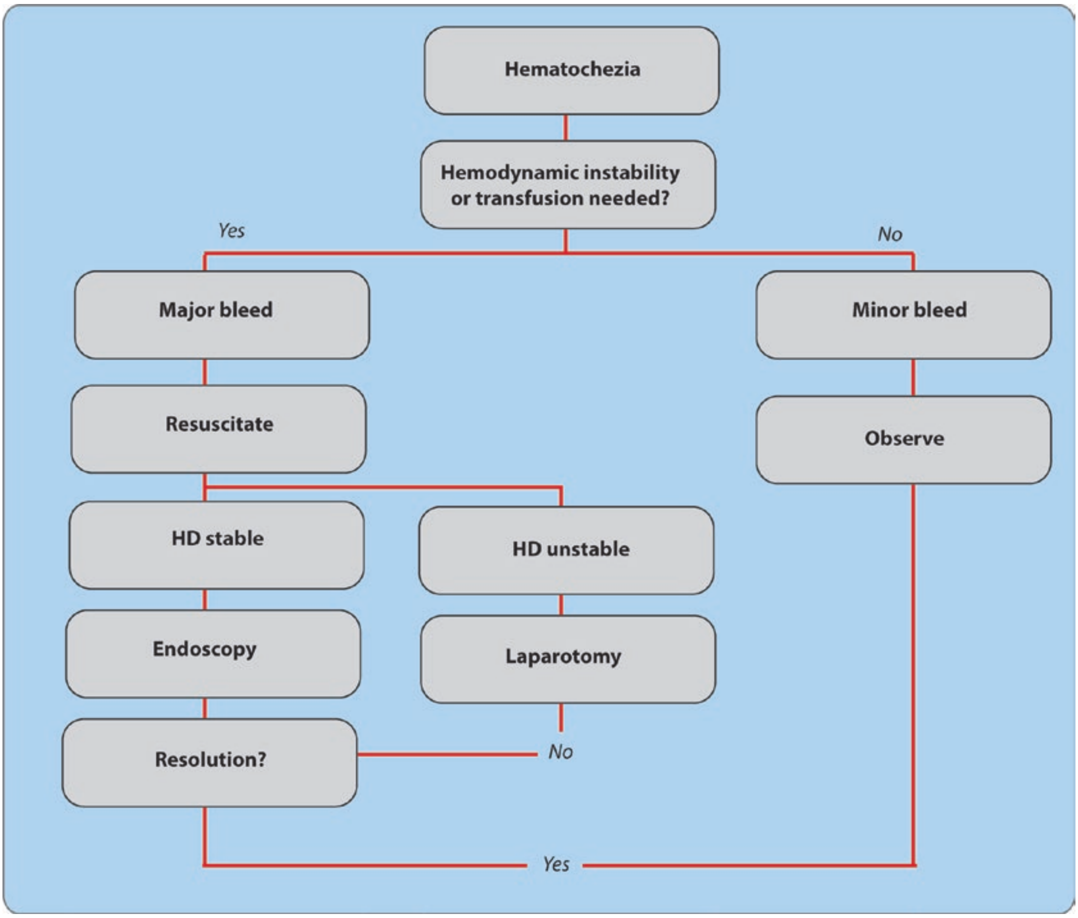

Fig. 85.4 Algorithm for management of anastomotic bleed

mosis in danger of ischemia which can result in leak acutely or stenosis at long-term follow up. If bleeding persists following non-operative interventions, then laparotomy to evaluate the anastomosis will be needed (Fig. 85.4).

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Late Anastomotic Complications (Stricture and Sinus)

86

David B. Stewart Sr.

Refer to Algorithms in Figs. 86.1 and 86.2

A. An anastomotic stricture represents an abnormal narrowing of the lumen of the anastomosis. While the narrowing is abnormal, whether is it actually pathological in the sense of representing a symptomatic lesion that mandates treatment is a separate consideration since mild and asymptomatic anastomotic strictures which do not require dilatation or resection are not uncommon. Conceptually, anastomotic strictures represent a form of "over-healing", with the deposition of scar tissue as elicited by a variety of factors to be discussed *infra*. By contrast, an anastomotic sinus tract is a blind ending, epithelialized tract emanating from the anastomosis and terminating within the pelvis or abdomen. This complication represents a late sequela of an anastomotic leak, one which developed slowly enough, and often through a small enough defect, that the patient may not have even developed any symptoms of infection. Sinus tracts can be discovered on endoscopy, though in many cases they are first noted on a water-soluble contrast enema obtained to evaluate the patency and healing of an anastomosis prior to the closure of a diverting stoma. For the purposes of this chapter, late anastomotic complications refer to those arising from colorectal anastomoses.

B. The incidence of colorectal anastomotic strictures is estimated to be as high as approximately 30%. There is even less data available to estimate the incidence of anastomotic sinus tracts. However, the incidence of both of these complications is high enough to make knowledge of their management important for a surgeon who frequently performs colorectal resections.

C. Both strictures and sinus tracts share a common pathophysiology. Causal factors include ischemia, which can occur due to failure to mobilize the mesentery of the preanastomotic colon to the midline peritoneal cavity, allowing for mobilization of the colon by resecting the mesentery in a proximal line of dissection adjacent to the retroperitoneum in order to preserve the nutrient arterial blood supply located closer to the wall of the colon. Additionally, failure to properly mobilize the colon can introduce tension on the anastomosis, which can lead to improper healing both through ischemia as well as through mechanotransductive forces. Incomplete stapler "doughnuts" represent a technical problem at the moment the end-to-end anastomosis was created, and may be due to a stapler malfunction or less

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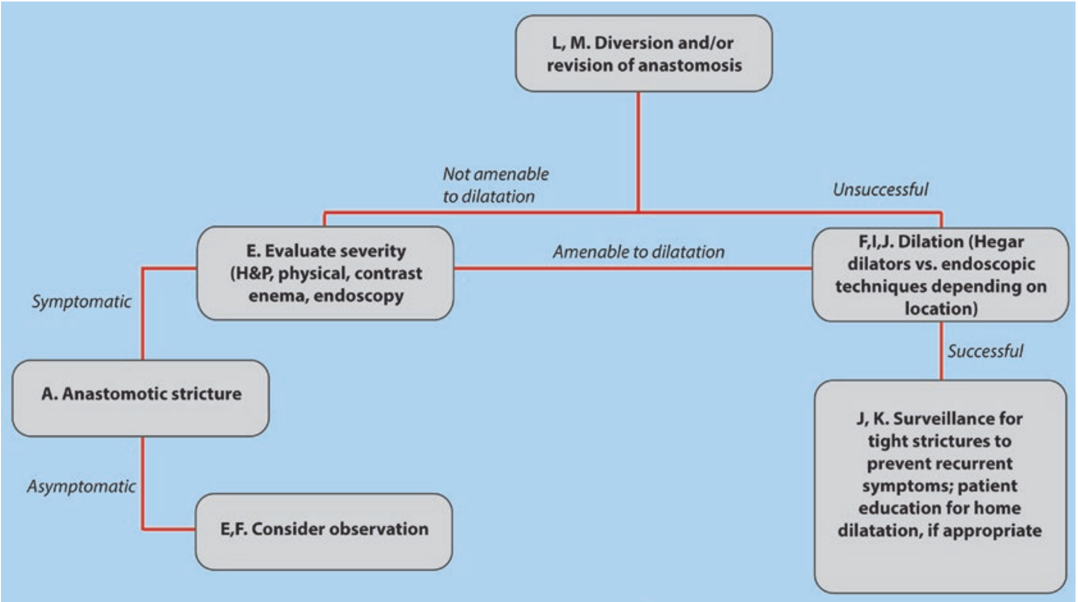

Fig. 86.1 Algorithm for treatment of anastomotic stricture

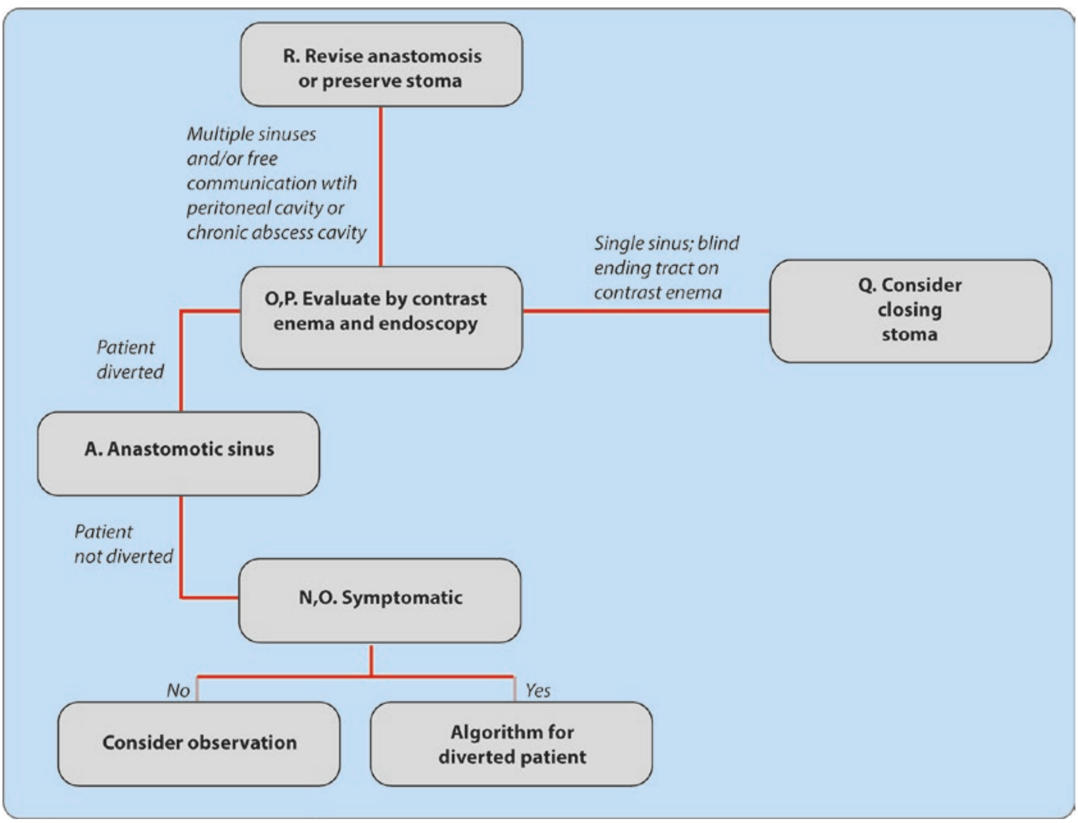

Fig. 86.2 Algorithm for treatment of sinus

than adequate surgical technique. The receipt of preoperative radiotherapy is a risk factor for a stricture or a sinus tract, as is the development of a clinical anastomotic leak treated with the construction of a diverting stoma.

D. Symptoms due to a colorectal anastomotic stricture are obstructive in nature, with the patient's symptoms determined by the consistency of their stool and the severity of the stricture. Symptoms include abdominal distention, colicky abdominal discomfort, and progressively worsening constipation characterized by a decreased stool frequency and/or a smaller size of stools. Sinus tracts, on the other hand, are more likely to be asymptomatic, especially in patients whose anastomoses are protected by a diverting stoma. In those patients who do develop symptoms, these are often characterized by pelvic pressure or discomfort, and fevers, reminiscent of a pelvic abscess which sinus tracts can give rise to. If the sinus tract is misdiagnosed as being blind ending when it is actually in continuity with the peritoneal cavity or a chronic cavity, then symptoms consistent with an anastomotic leak will develop.

E. Diagnosis will incorporate physical examination, endoscopic and radiographic approaches. Assessment should begin with digital anorectal exam, noting sphincter tone, assessing for obstructing lesions distal to the anastomosis, and if possible, digitally examining the anastomosis. Palpation of the anastomosis can assess strictures as being either "soft" and without a predominance of fibrotic tissue versus strictures which are more fibrotic. Soft strictures are frequently associated with new anastomoses which are diverted, with portions of the anastomotic staple line adhering one to another. This form of stricture is frequently amenable to dilatation, either with the surgeon's examining finger or by rigid proctoscopy. Strictures which are more chronic are frequently associated with a significant degree of fibrosis, and even if digital or endoscopic dilatation is successfully performed, these strictures will often have high recurrence rates, requiring repeat treatments. Digital examination is more useful for diagnosing and evaluating strictures than sinus tracts.

F. The use of a standard 15-mm rigid proctoscope or a standard adult flexible colonoscope can be used to visualize the colorectal anastomosis. Difficulty or inability in traversing the anastomosis is evidence of a stricture, though in asymptomatic patients this finding may not mandate treatment if the anastomosis is not strictured to a degree where only a small lumen remains. Sinus tracts are also able to be visualized via endoscopy, delineating the number of sinus tracts, their location and the size of their internal opening. It will be important during an endoscopic exam to evaluate the preanastomotic colon, if possible, for evidence of ischemia, and in the setting of a prior surgery performed for cancer, to evaluate the anastomosis for evidence of cancer recurrence. Further, in patients who have received prior radiotherapy, the examiner should evaluate the rectum for evidence of radiation proctitis, especially with regard to the length of remaining rectum and its distensibility. Therefore, endoscopy is not only valuable for diagnosing the nature of the anastomotic complication, as well as for potentially providing therapeusis in the form of pneumatic dilatation, it also provides information about the preanastomotic colon and the remaining rectum that will help inform the surgeon's decision making and how the patient is counseled.

G. Radiographically, the most appropriate study would involve a water-soluble contrast enema, although a rectal contrast enhanced CT scan would also suffice. A study of this type is irreplaceable, since this study will confirm whether an anastomosis is watertight, which an endoscopic exam cannot do. In the case of a fluoroscopic contrast study, information regarding the distensibility of the remaining rectum and the preanastomotic colon can be assessed in real-time, and images documenting the degree of obstruction to the regress of contrast, or documenting

the number, length and trajectory of sinus tracts, is provided.

H. Anastomotic strictures which are symptomatic and thus require addressal are approached in the following manner. Since reoperative pelvic surgery is challenging, dilatation is frequently the first preferred intervention. For distal strictures well within the reach of an examining index finger, digital dilatation can be employed, though for severe strictures which will not allow enough traversal to dilate the anastomosis, a different initial approach is required. Hegar dilators can be useful in these scenarios, having utility during an exam of the anorectum under anesthesia, and even allowing patients to perform dilatations themselves at home.

I. Most patients with an anastomotic stricture will require more than a digital dilatation or the use of Hegar dilators. Endoscopic dilatation is a very effective intervention for anastomotic strictures, especially for strictures which are short (<2-cm). Pneumatic (balloon) dilatation is the most frequent endoscopic dilatation technique, with the goal of producing a lumen which will allow traversal with a 12-mm flexible colonoscope. Patients should be counseled that they may require serial dilatations toward a patent anastomosis, approaching this process in a step-wise manner for more severe, more fibrotic strictures in an effort to avoid an endoscopic perforation. Patients should also be made aware of the possibility of requiring repeat endoscopic dilatations to address recurrent strictures.

J. Endoscopic self-expanding metallic stents generally have no role in colorectal anastomotic strictures, due to the tenesmus and the higher likelihood of stent migration associated with their placement in the rectum.

K. Certain strictures are extremely fibrotic, and are not appropriately addressed by pneumatic dilatation alone. Endoscopic techniques allow for a stricturotomy, creating an incision often with the use of an endoscopic laser or an endoscopic scalpel. This technique can be combined with balloon dilatation to improve success rates, and to prevent recurrences of symptomatic strictures.

L. If endoscopic intervention is not successful in the setting of a severe stricture, a diverting stoma may be necessary, either as a palliating intervention to relieve the patient's obstructive symptoms, or potentially as a long term or definitive solution to an obstructing stricture. Leaving the strictured anastomosis *in situ* has its disadvantages, which include chronic pelvic pressure and the chronic urge to defecate. Additionally, endoscopic cancer surveillance will not be possible per anorectum with an obstructing stricture, requiring the endoscopist to traverse a diverting stoma in order to reach the distal large intestine. This approach to screening can be technically challenging and is often unsuccessful.

M. The decision to divert a patient should take into account the severity of the patient's obstruction, considering the degree of urgency created by the patient's colonic obstruction and whether the patient is amenable to further attempts at endoscopic intervention. Whether this diverting stoma is viewed as temporary or permanent may influence the decision to construct a colostomy versus an ileostomy, as the former as generally easier to care for, especially in the elderly. For those patients in whom diversion is viewed as a bridge to additional surgery, a diverting ileostomy may be a better option than a colostomy, since at the time of the subsequent resection of the strictured anastomosis, it is highly advised that this new anastomosis (if one is able to be constructed) be diverted to protect against additional anastomotic complications.

N. The management of sinus tracts is more controversial, since these are often discovered incidentally in the absence of symptoms during preparations for the closure of a diverting stoma. In the most common scenario, a water-soluble contrast enema reveals the presence of a blind ending tract. The obvious concern is that if a diverting stoma is closed in this setting, a pelvic abscess or a clinical anastomotic leak may develop.

O. For multiple anastomotic sinus tracts noted on contrast enema or endoscopy, it is ill-advised to simply close a diverting stoma in this setting. The finding of multiple tracts indicates that a more significant problem occurred during the construction of the anastomosis, and thus it is more likely that closure of the diverting stoma will be associated with symptoms from these tracts.

P. There are endoscopic techniques using metallic clips of various sizes which can be employed to close the internal opening of a sinus tract. This approach would be best applied to shorter length tracts. The concept involves closure of the internal opening, thus preventing any further communication between the lumen of the anastomosis and the tract. Resolution of the tract is possible for extremely short tracts, though given that these tracts are usually epithelialized, this is not a common outcome.

Q. For immunocompetent patients who are in reasonably good health, closure of a diverting stoma is an acceptable alternative for patients with a single sinus tract which is short, blind ending, well-visualized by contrast enema and which does not terminate into a chronic cavity. A fluoroscopic study as opposed to a rectal contrast enhanced CT scan may be better suited for these purposes. Patients should be counseled regarding the possibility of requiring an unplanned surgery, with construction of another stoma, should pelvic sepsis occur after closure of their stoma.

R. For either strictures or sinus tracts, resection of the anastomosis is sometimes required. Such patients should be counseled regarding their higher degree of risk for reoperative pelvic surgery, and they should be of reasonably good health. The possibility of requiring a permanent stoma, and the high likelihood of requiring at least a temporary stoma, should be mentioned. Surgeons should consider having localizing ureteral stents placed at the time of this surgery. The patient's overall functional status, any prior receipt of radiotherapy, and the patient's preoperative degree of continence should be taken into consideration in the decision to attempt construction of a new colorectal or coloanal anastomosis, versus performing a completion proctectomy with a permanent colostomy.

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87 Post-polypectomy Bleeding

Avery S. Walker and David A. Margolin

Refer to Algorithm in Fig. 87.1

A. Post-polypectomy bleeding is the most common complication of colonoscopic polypectomy, occurring in 0.3–6.1%. Bleeding can immediately occur or occasionally present in a delayed fashion even up to 30 days after polypectomy. Bleeding can range from mild and easily treatable to severe and life-threatening hemorrhage, requiring additional endoscopic, angiographic, or surgical interventions. There is an abundance of literature on defining the risks of post-polypectomy hemorrhage with most reports identifying the type and size of polyp, the technique of polypectomy, and the coagulation status of the patient. In most of cases, immediate post-polypectomy bleeding can be controlled endoscopically. Conversely, delayed polypectomy bleeding most commonly resolves with conservative treatment, although therapeutic intervention is occasionally needed. Clinically significant delayed bleeding is defined by hematemesis, melena, and/or hematochezia, with a drop in hemoglobin >2 g/dL. Medical stabilization is of extremely important before endoscopic therapy is started for delayed bleeding. The approach is the same as it is for all other colonic hemorrhage. Stabilization should be the goal to include adequate volume resuscitation while avoiding volume overexpansion, blood product administration as appropriate, and reversal of coagulopathy. Many patients (i.e. those with atrial fibrillation or those with coronary artery stents) are receiving antithrombotic agents, which may require reversal agents, fresh frozen plasma, or platelet transfusions. The advice of a cardiologist or internist should be sought so that fatal thrombotic events (such as occlusion of coronary stents) do not occur. Liver disease causing coagulopathy and those patients with significant thrombocytopenia (platelet count <50,000) from any cause may benefit from transfusion of fresh frozen plasma and platelets, respectively, prior to colonoscopy and during the resuscitation process.

Admission to the intensive care unit may be indicated if the bleeding is severe enough to cause hemodynamic instability. Bedside endoscopic intervention can then be performed with critical care support rather than transporting the patient to the endoscopy suite or the operating room. In patients with suspected post polypectomy bleeding, rapid colonic preparation administered orally or via a nasogastric tube can be performed in those who require urgent colonoscopy, although the

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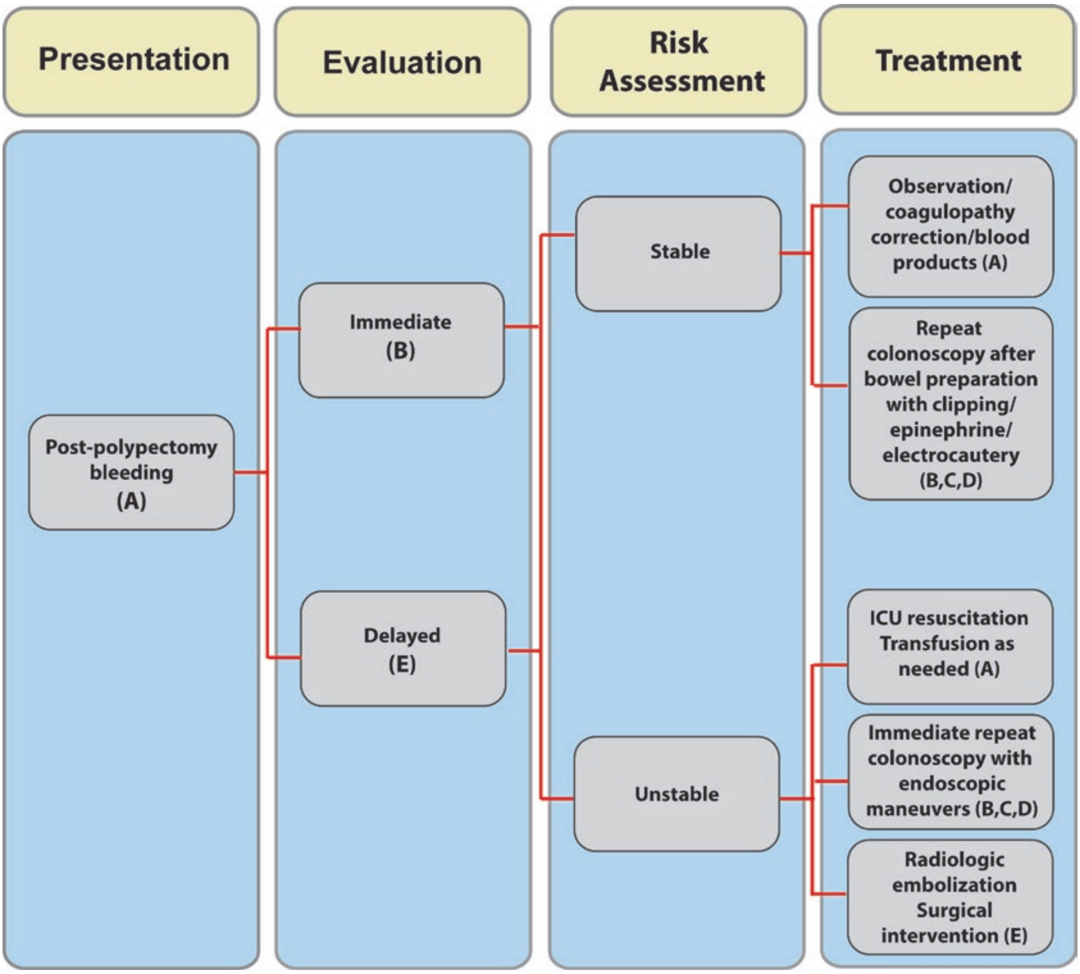

Fig. 87.1 Algorithm for Post Polypectomy bleeding

cathartic effect of colonic bleeding may decrease the need for full bowel preparation.

The decision to perform and timing of colonoscopy in patients with post-polypectomy bleeding is not standardized. As most post-polypectomy bleeding stops without intervention, one approach is to administer a bowel preparation and follow the stool pattern. If the patient presented with clinically mild bleeding, has few comorbidities, remains hemodynamically stable, and the bowel contents clear of blood, withholding colonoscopy may be a reasonable option, and one could choose to simply monitor the patient.

B. Immediate post-polypectomy bleeding has been reported in series ranging from 1.5% to 2.8% following polypectomy. Most procedural bleeding is self-limited, does not interfere with the procedure, and resolves without intervention by the time the procedure is completed. Procedural bleeding is considered an adverse event if it causes the procedure to be aborted or alters procedural management. The risk increases when blended current is used and when cold snaring is performed to remove the polyp. For snared pedunculated polyps, if immediate bleeding is observed, grasping the stalk with the polypectomy snare and holding it for 5–10 min is the quickest and easiest method to control bleeding. This method causes compression of the bleeding source and permits the endoscopy staff to

prepare clips or an injection needle with epinephrine, before hemorrhage obscures the field. Endoscopic clipping is widely used to control post-polypectomy bleeding for either immediate or delayed bleeding. Multiple endoscopic clips are available for use (Quickclip2, Olympus Inc.; Resolution Clip, Boston Scientific Inc.; Instinct Endoscopic Hemoclip, Cook Endoscopy, Winston–Salem, NC, USA). An over-the-scope clip (Ovesco Endoscopy AG, Tuebingen, Germany) has also become available. This device has the ability to grasp a much wider area and larger volume of tissue than the small endoscopic clips. The device has been used primarily for closure of perforations or fistulae, but has also been shown to be an effective treatment for post-polypectomy bleeding (Fig. 87.2). The clips can be placed onto a bleeding residual stalk or placed just lateral to the bleeding site for sessile polyps to tamponade any supplying blood vessels. While endoscopic clips can be placed prophylactically at the polypectomy site after removal of either pedunculated or sessile polyps, the benefit has not been confirmed in the literature. When no part of the stalk is left, or in the case of sessile polyps, clips are applied on any visible vessel or on the post-polypectomy ulcer (Fig. 87.3).

C. A dilute epinephrine solution (1:10,000) is typically used to control rapid immediate post polypectomy bleeding, which makes visualization difficult. A field effect of vasoconstriction and the subsequent tamponade is the result of using epinephrine. This characteristic aspect of epinephrine accounts for the non-mandatory precise localization of the bleeding site allowing for relatively simple application. Thermal or mechanical hemostasis should still be performed when possible, as the effects of epinephrine injection are short-lived.

D. Electrocautery can be an effective method to control immediate post-polypectomy bleeding, however, it is not without risk. Bipolar contact thermal electrocoagulation probes such as Gold Probe (Boston Scientific Inc., Natick, MA, USA) and the heater probe

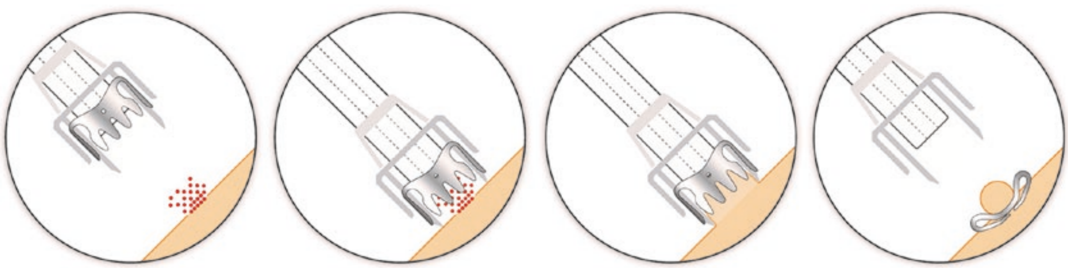

Fig. 87.2 Application of the Ovesco OTSC System for hemostasis (Ovesco Endoscopy AG, Tuebingen, Germany). (Reused with permission)

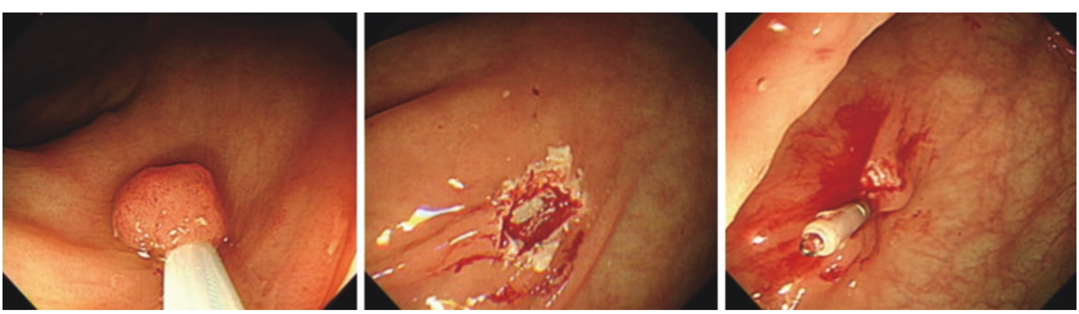

Fig. 87.3 Application of an endoscopic clip after polyp excision and subsequent post-polypectomy bleeding

(Olympus Inc., Tokyo, Japan) are available electrocautery devices. Argon plasma coagulation is an example of a non-contact thermal electrocautery technique (ERBE USA Inc., Marietta, GA, USA; Beamer, ConMed Endoscopic Technologies, Utica, NY, USA). When compounded by tissue damage already caused by prior therapy (i.e. hot snare resection), the risk of perforation increases when electrocoagulation techniques are employed. Pressure applied by contact thermal probes can also lead to perforation and extreme caution is advised when using this technique. Increased care must be observed in the right colon where the colon wall is the thinnest. Here the current should be decreased by approximately 50% relative to that used for the initial polypectomy. For a contact thermal probe, 15 J is safe and 10–15 W for bipolar cautery.

E. Most delayed post-polypectomy bleeding can be managed with observation alone. However, there is a subset of delayed post-polypectomy patients who do not stop bleeding and need therapeutic intervention. This group includes patients who are on anti-coagulants and anti-platelet agents or had large polyps removed, i.e. >2 cm. If bleeding recurs after initial endoscopic therapy, repeat endoscopic therapy may be useful. The same or alternative endoscopic therapies can be employed. For refractory bleeding, interventional radiologic approaches with embolization can and should be considered before surgery. Institutions with endoscopists and interventional radiologists are readily available, surgery is considered a last resort for management of post-polypectomy bleeding that cannot be controlled by the above techniques. Emergent salvage surgery is rarely needed to prevent death from exsanguination. Ideal lesions for surgical management include colonic lesions that are localized, and if proven malignant, would otherwise be best managed surgically (i.e. malignant invasive colorectal polyp).

Conclusion

Bleeding is the most common post-polypectomy complication during and after colonoscopy. Most bleeding can be effectively managed with the endoscopic techniques described along with sufficient hemodynamic support. The selection of a particular technique is dependent on lesion characteristics and location, device availability, and operator preference. Therefore all endoscopists should know and master the different endoscopic techniques available to successfully treat post-polypectomy bleeding.

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88 Post-polypectomy Complications

Sandra Rodriguez and Tolga Erim

Safety of Colonoscopy

Colonoscopy is the gold standard for prevention and diagnosis of colorectal cancer. The procedure is generally well tolerated. Complications are rare but they do occur, and can be life threating. A meta-analysis published in 2016, which included 1,966,340 colonoscopies, reported an overall complication rate of 0.5 per 1000 colonoscopies. The pooled prevalence for perforation, bleeding, and overall mortality were 0.5/1000 (95% confidence interval (CI) 0.4–0.7) colonoscopies, 2.6/1000 (95% CI 1.7–3.7) colonoscopies, and 2.9/100,000 (95% CI 1.1–5.5) colonoscopies respectively. Complication rate is lower for screening and surveillance procedures than for diagnostic examinations. Recognition of pertinent risk factors can help in preventing complications. These can be grouped into patient-related, polyp-related, and technique/device-related risks.

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Electrosurgical Currents

There are three types of electrosurgical currents are available: pure cut current, pure coagulation current, and blended current. Pure cut current is 100% on continuous sinusoidal wave energy delivery without a cooling-off period and is associated with a higher risk of immediate bleeding. Coagulating current has a hemostatic effect, which allows for tissue cooling, resulting in less immediate bleeding but higher incidence of delayed bleeding. Blended current refers to high frequency modalities, in which an electrosurgical generator unit (ESGU) provides short bursts of pure cutting current, separated by intervals soft coagulation current. With Blended current, some cells are cut while others are coagulated depending on the amount of voltage and what percentage of the cycle it is applied. Blended current modes are commonly used in polypectomy (Fig. 88.1).

Modern ESGUs are able to detect the resistance and impedance of the tissues, varying the power output accordingly. The characteristics of the blended waveform setting vary depending on the manufacturer and model of the ESGU. It is essential to know the characteristics of the ESGUs used in an endoscopy unit. Ultimately the choice of electrosurgical current generally depends on the experience and judgment of the endoscopist. Of the three modes discussed, the blended wave may be the best suited for incision and effective hemostasis. In general, at identical

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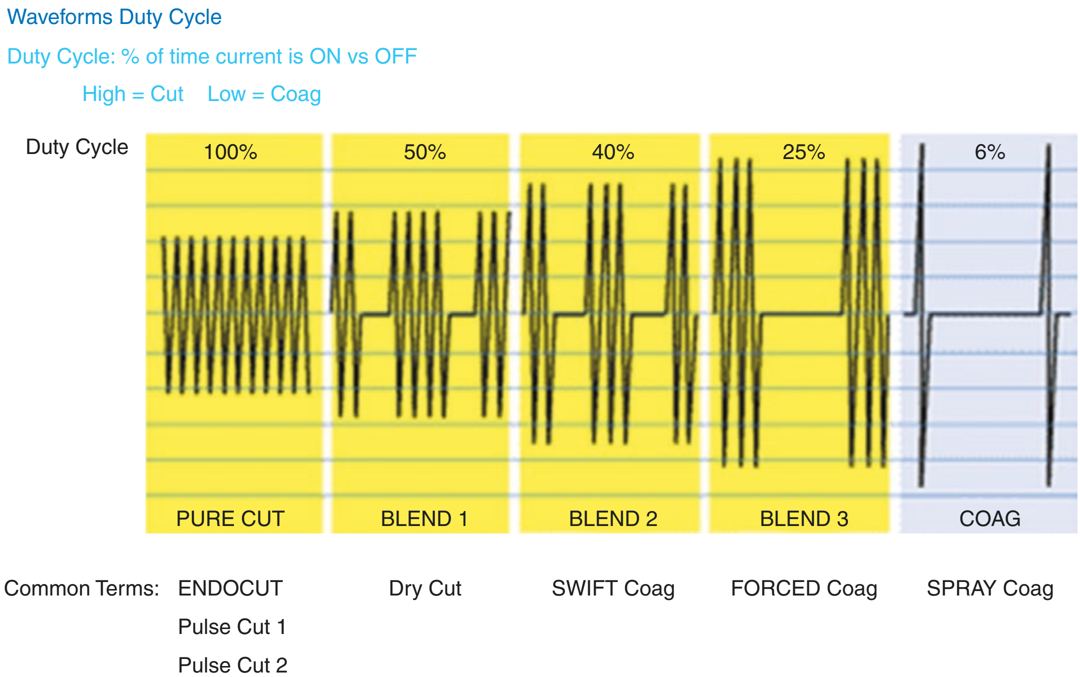

Fig. 88.1 Available current modes

power settings, the depth of tissue injury caused by coagulation current can be significantly greater compared with pure cut and blended current. This greater depth of injury is thought to be responsible for PPTI and its complications, namely delayed bleeding, post-polypectomy serositis pain and perforation.

Polypectomy Techniques and Prevention of PPTI

Techniques of polypectomy are classified according to the type of instrument used and according to whether an ESGU is used. “Hot” polypectomy refers to the technique using the ESGU and “cold” entails without the use of ESGU. Polyps are classified by their size as diminutive (<5 mm), small (5–9 mm), and large (≥10 mm) and morphology. Large (≥10 mm) and adenomatous polyps should be removed because of their malignant potential. The choice of instrument and the technique used depends on the size and morphology of the polyp. Adenomatous diminutive and small polyps are frequently found during screening colonoscopy. Cold biopsy forceps polypectomy is the most commonly used technique for the removal of these types of polyps. This method is readily available in all endoscopy suites, is simple to use, has a relatively low cost, and is associated with a high polyp-retrieval rate. However, relatively high rates of incomplete resection have been reported. The use of a snare or a jumbo biopsy forceps reduce the risk of incomplete removal by 60%.

The use of hot biopsy forceps (HBF) has been linked with the development of perforation, serositis, delayed bleeding, and incomplete resection. Its use results in deeper tissue injury compared with snare polypectomy, regardless of the diameter of the snare loop. Therefore the use of HBF for polypectomy is not encouraged nowadays. For diminutive and small polyp resection, the use of cold biopsy forceps or cold snare is recommended.

For larger size polypectomies the use of electrosurgery is preferred. Pedunculated polyps are easily removed by snare resection at the stalk. It is important to time the closure of the snare carefully with the application of current to minimize

depth of injury but still assure proper coagulation of the blood vessels in the stalk. In resection of flat polyps, lesions greater than 2 cm should be resected piece-meal and with submucosal lift assistance to decrease risk of perforation. Endoscopic mucosal resection (EMR) is a minimally invasive, organ-sparing procedure that can also be used for the removal of large sessile or flat lesions confined to the superficial layers (mucosa and submucosa) of the gastrointestinal tract. The commonly used techniques include injection, cap, and ligation-assisted EMR. Other techniques such as endoscopic mucosal dissection (ESD) can be used to remove early malignant lesions, but are beyond the scope of this chapter.

Other devices such as monopolar and bipolar probes, hemostatic forceps and argon plasma coagulation (APC) probe have no role in polypectomy. These can be used to treat post procedure related bleeding and also after polypectomy or EMR to ablate the edges of the resection area in order to decrease risk of residual polyp tissue and recurrence. APC is a non-contact, thermal hemostatic method in which argon gas is heated up by high frequency current, forming a plasma that conducts energy into the tissues. The depth of penetration into the tissue can be very deep but if used cautiously as a spot treatment then it is usually limited to the superficial surface, rendering it very safe. However, the application of APC to ablate residual adenomatous tissue has been associated with a higher risk of adenoma recurrence. More recently, a more practical and less costly method of using snare tip cautery for ablation of the resection margins and hemostasis has shown promising results.

Complications of Post-Polypectomy Complications and their Treatment

Post-polypectomy Bleed (see Chap. 87)

The overall rate of postpolypectomy bleeding (PPB) has been reported to be as high as 9.8/1000 colonoscopies. A time-trend analysis published recently showed that the rate of PPB has declined from 6.4 to 1.0/1000 colonoscopies from the years 2001 to 2015, likely due to decreased use of coagulation in removal of small polyps and use of endoclips. Bleeding usually occurs within the first 2–3 days but it can be delayed up to 3–4 weeks post intervention. The use of pure cut or blend current have been related to the development of immediate bleeding, whereas pure coagulation current is mostly associated with a delayed hemorrhage. Immediate bleeding is preferred over delayed bleeding as its control is rather easily accomplished in most cases during the procedure. In addition to the current type and power setting, other factors play a major role in the development of PPB.

The technique of polypectomy has been demonstrated to be an independent risk factor for the development of PPB. Namely, the type of the device used, and the mechanical forced applied to it. When performing a snare polypectomy the mechanical force with which this device is closed depends on the type of snare used and on the tissue resistance/impedance. The snare should be closed gradually to give time for the current to coagulate as it makes its way through the tissue. The thinner the snare wire, the slower should be the snare closure. On the contrary, the higher the intensity and the coagulating ability of the applied current, the greater must be the force applied to the snare.

The size and location of the polyp have also been shown to be independent risk factors for the development of PPB. Multiple studies have reported higher rates of immediate and delayed bleeding with resection of polyps greater than 2 cm, especially in the right side of colon. A thick polyp stalk may contain large blood vessels and thus after resection it may be more difficult to achieve hemostasis. Other factors that have been demonstrated to contribute to the development of PPB include multiple polypectomies, polyp morphology, anticoagulation use, coagulopathy, experience of the endoscopist, and quality of the bowel preparation.

Bleeding is the most common adverse event of EMR. Intraprocedural bleeding rates after EMR of colorectal lesions larger than 20 mm are reported to be between 11% and 22%. Risk factors for intraprocedural bleeding include lesion size, Paris endoscopic classification of 0-IIa þ Is, tubulovillous or

villous histology, and low-volume institutions. Delayed bleeding rates after EMR of large colonic polyps range from 2% to 11%. Risk factors for clinically significant postprocedural bleeding included a proximal colonic location, polyp size, and intraprocedural bleeding.

The use of lifting technique has been demonstrated to reduce the rate of PPB, especially when performing larger polypectomies or EMR procedures. Submucosal fluid will act as a cushion, which reduces tissue resistance, making the passage of the snare through the tissue easier and faster. Once resection is completed any visible vessels or bleeding points should be treated with coagulation forceps or the tip of the snare. Adrenaline (epinephrine) solution diluted with saline its effective in preventing immediate bleeding and also in treating PPB. It should be combined with a second hemostasis modality such as mechanical or contact thermal therapy to achieve definitive hemostasis.

In case of bleeding after resection of pedunculated polyps, the stalk can be held tightly the same hot snare to slow down bleeding and achieve immediate hemostasis. A detachable nylon loop ligation device can also be placed at the base of the polyp for similar purpose. Electrocautery can be used for treatment as well, but should be used with caution, particularly in the ascending colon, due to the increased risk of perforation.

Clipping is effective in managing PPB. More recently the use of endoscopic clips has been studied for prevention of PPB. Overall prophylactic clipping of resection sites after EMR of >2 cm lesions using coagulation current have been shown to reduce the rate of delayed post-polypectomy hemorrhage associated with large endoscopic mucosal defects. Its prophylactic use however to prevent PPB after removal of smaller lesions has not been demonstrated.

Over-the-scope-clip (OTSC) consists of a large clip shaped as a bear trap allowing for inclusion of larger amount of tissue (≥20 mm). It can be used in case of massive bleeding from a large removed lesion or if standard endoscopic clips are not sufficient to ensure an adequate compression of a large vessel. The rate of complications reported with its use is low.

Perforation

Perforation rate associated with colonoscopy is approximately 0.8/1000 colonoscopies. The mortality rate associated with iatrogenic perforation ranges from 0% to 0.65%. The incidence of perforation is higher following a therapeutic than diagnostic colonoscopy. With regards to patient's risk factors the presence of adhesions, severe diverticular disease, mucosal inflammation, stenosis, multiple comorbidities, advanced age, and poor bowel preparation are associated with a higher risk of perforation.

Perforations are classified as macro and micro perforation, and can be recognized intra-procedurally or can present later on. With regards to polypectomy technique, risk factors associated with the development of perforation include limited operator experience, removal of polyps >1 cm, polypectomy in the right colon, multiple polypectomies and incorrect use of cutting or coagulation current. Special attentions should be paid during removal of polyps in the cecum, where the thin wall may predispose to perforation.

Perforations related to PPTI tend to be smaller in size. Both degree and duration of electrocautery play a role. Pre-polypectomy, submucosal injection of a lifting solution for creating a fluid cushion, which separates the mucosa-submucosa layers has been found to reduce the risk of electrocoagulative damage to the muscularis propria, thereby reducing the risk of perforation. The use of blended modes may lead to far less deep tissue damage than a pure coagulation mode. Increased risk of perforation exists with the use of HBF even after removal of small polyps. It is worth mentioning again that a much lower risk has been reported with cold snare polypectomy.

EMR and ESD are increasingly being performed and they carry a definite risk of perforation. A meta-analysis comparing the effectiveness and safety EMR and ESD showed that ESD resulted in a higher perforation rate (OR = 5.27; 95% CI, 2.75–10.08; Z = 5.01; $P < 0.00001$). Limited operator experience is associated with an increased risk perforation during both of these procedures.

Colonic perforation can be managed non-operatively or surgically. Choice of treatment

depends on several factors, such as the site and size of injury, and the clinical stability of patient and the quality of the bowel preparation. Those patients meeting criteria for conservative management can be treated with bowel rest, intravenous antibiotics and close observation.

Clip placement can be used to seal small immediately visible perforations in order to avoid abdominal contamination and subsequent surgery. The likelihood of success of this therapeutic modality depends on the size of the perforation; the smaller the perforation the higher the chances it can be managed endoscopically. The use of OTSC in the treatment of immediately visible perforations has also been described. Recent studies have shown that the rate of procedural successful ranges from 80–100% without major complications and that their use may reduce the need for surgery.

Partially or totally covered stents can be used for closure of a perforation, however, there is a high probability of stent migration even in the presence of stenosis. There is high risk of intolerance and tenesmus in the case of low rectal stent positioning.

Postpolypectomy Electrocoagulation Syndrome

This is a less common entity, also known as post-polypectomy syndrome or transmural burn syndrome. Electrocoagulation injury results in transmural inflammation involving the serosal layer, which causes a localized peritoneal irritation. It is associated with acute onset abdominal pain mimicking colonic perforation without radiological evidence of perforation. The incidence ranges from 0.003% to 0.1%. It occurs most frequently after removal of non-polypoidal lesions, large lesion size (>2 cm), lesions on the right side of the colon (attributed to decreased wall thickness). Conservative treatment with bowel rest, intravenous fluids and antibiotic therapy usually lead to symptom resolution in a few days. The submucosal injection of a fluid cushion would likely minimize the occurrence of this complication.

Summary of Recommendations

Refer to Table 88.1 and Algorithm in Fig. 88.2

A. Prevention and management of PPB
  (a) Effective bowel preparation reduces the risk of bleeding
  (b) Injection of a lifting solution to separate a flat polyp from the submucosal layer and its vessels decreases risk of PPB
  (c) The snare must be accurately positioned to ensure the lifting of the mucosa from the underlying muscle and limit the

Table 88.1 Prevention and treatment of complications related to PPTI

Post-polypectomy thermal injury		
Prevention	Effective bowel preparation	
	Injection of lifting solution	
	Avoid use of hot biopsy forceps	
	Accurate positioning of snare to limit amount of tissue in loop	
	Use blend current or pure cut rather than pure coagulation current	
	Post-polypectomy Bleed	**Perforation**
Treatment	Hemostasis with Epinephrine	Clip placement
	Cautery of visible vessel with tip of snare, monopolar/bipolar coagulation, APC	OTSC device
	Mechanical clips	Partially or fully covered stents
	Detachable nylon loop ligation device	Referral to a tertiary center if performing EMR
	Resnaring	
	OTSC device	

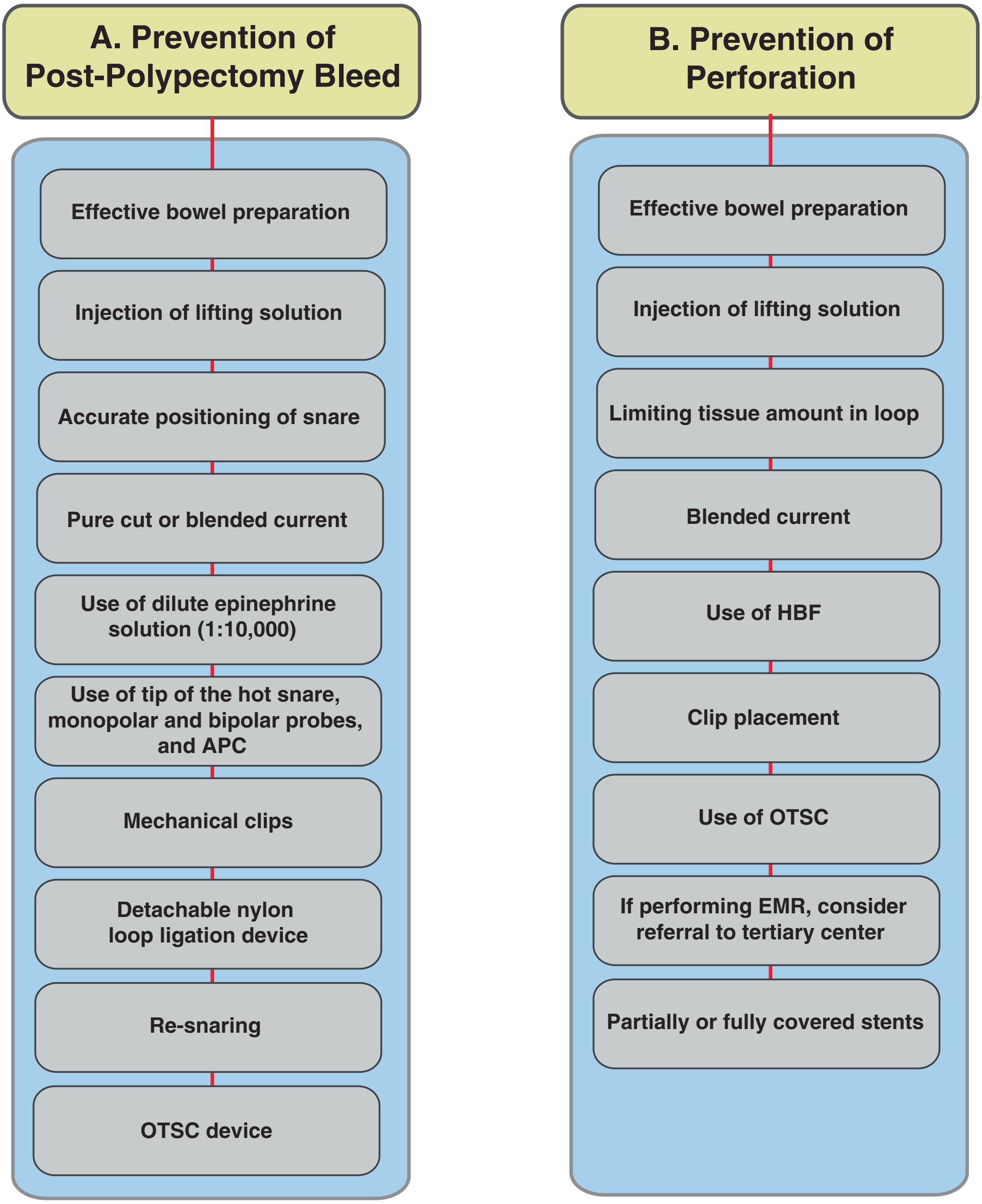

Fig. 88.2 Algorithm for management of post-polypectomy complications. *APC* argon plasma coagulation, *OTSC* over-the-scope clip, *HBF* hot biopsy forceps

amount of tissue included in the loop to a maximum of 2 cm

(d) The use of pure cut or blend current is more likely to lead to immediate bleeding that can usually be easily controlled during the procedure, whereas pure coagulation current results in delayed hemorrhage

(e) Dilute Epinephrine solution (1:10,000) can be used to prevent intraprocedural bleeding and to gain initial control of an active bleeding lesion and improve visu-

alization if PPB occurs. This should always be done in combination with a second hemostasis modality including mechanical or contact thermal therapy to achieve definitive hemostasis

(f) The tip of the hot snare, monopolar and bipolar probes, and APC can be used to treat any visible vessels or bleeding points that may remain at the end of the polypectomy

(g) Mechanical Clips can be used to manage any immediate intraprocedural bleeding and they should also be used prophylactically to zip any large mucosal defects after removal of polyps that are >2 cm in size

(h) Detachable nylon loop ligation device can be used for pedunculated polyps, if the residual stump is sufficiently long, the loop can be positioned over it and released to ensure hemostasis. The loop can also be used prophylactically prior to resection by placing at the base of the stalk and snaring above it

(i) Re-snaring can be used to manage bleeding from pedunculated polyps. The same snare utilized for the resection can be used to grasp the stump of the stalk holding it for few minutes without applying current. During this period of time, mechanical arrest of the bleeding can be achieved and while preparing to treat with a more permanent method for hemostasis

(j) OTSC is a device can be used in case of massive bleeding

B. Prevention and management of Perforation (Table 88.1) and Algorithm in Fig. 88.2

(a) Effective bowel preparation reduces the risk of perforation as well as the risk of infection associated with perforation

(b) Pre-polypectomy injection of lifting solution to separate a flat polyp from submucosa layers and its vessels reduces damage to muscularis mucosa decreasing rates of perforation

(c) Limiting the amount of tissue included in the loop to a maximum of 2 cm reduces risk of perforation, these larger polyps should be resected in piece-meal

(d) The use of blended modes causes less deep tissue damage than a pure coagulation mode

(e) Avoid the use of HBF since their use is associated with increased risk of perforation

(f) Clip placement can be used to seal immediately visible perforations

(g) OTSC can also be used successfully for management of perforation with low risk of complication, allowing for large amounts of tissue to be grasped

(h) If performing an EMR, consider referral to a tertiary center as limited operator experience has been shown to increase the risk of perforation

(i) Partially or fully covered stents can be used in the management of perforation but they carry a high risk of migration and perforation

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89 Presacral Bleeding

Avery S. Walker and David A. Margolin

Refer to Algorithm in Fig. 89.1

A. Massive presacral bleeding can potentially be life-threatening in the setting of rectal surgery and is considered one of the most challenging situations within the scope of colorectal surgery. The incidence of massive presacral bleeding is reported as high as 9.4%, with a mortality rate of 4.3% in primary pelvic surgery. In the setting of recurrent rectal cancer or reoperative surgery, this incidence is significantly increased. Multiple hemostatic techniques have been described to control presacral bleeding including suturing, tacks, bone wax, and packing. Here we provide an algorithm to control presacral bleeding based on our experience

B. The presacral venous plexus (PSVP), comprised of the avalvular lateral and middle sacral veins with anastomosis to the basivertebral vessels, are not usually exposed during rectal mobilization when the dissection is carried out in the proper plane (Fig. 89.2). During the posterior rectal dissection, it is recommended to proceed into the plane between the fascia propria of the rectum and the presacral fascia. It has been estimated that with the patient in the lithotomy position, the hydrostatic pressure in the presacral space is up to three-times that of the inferior vena cava, causing a dramatic flow of approximately 1000 cc/min of blood from a 2–4 mm vein.

C. As soon as presacral bleeding is identified, the first maneuver performed should be direct pressure at the point of bleeding followed by aspiration of the accumulated blood for appropriate visualization of the bleeding site. Conventional hemostatic techniques tend to fail and may exacerbate the bleeding by shearing adjacent veins and extending the bleeding surface. As in trauma surgery, pelvic packing with laparotomy pads is effective and may be a life-saving maneuver. This allows time for the anesthesia providers to resuscitate the patient and the surgeon the opportunity to plan and obtain supplies for the ensuing challenge. If needed, such as an inability to control the bleeding, packing can be left in place for 48–72 h; however, this requires a reoperation with the risk of anastomotic disruption or pelvic sepsis due to the presence of a foreign body.

D. Tacking is a popular technique that works well. Metallic thumbtacks were first used in 1985 and have advanced to the current tacks with coagulant material associated with the tack. There are commercial devices for the placement of the tacks, however, one of the

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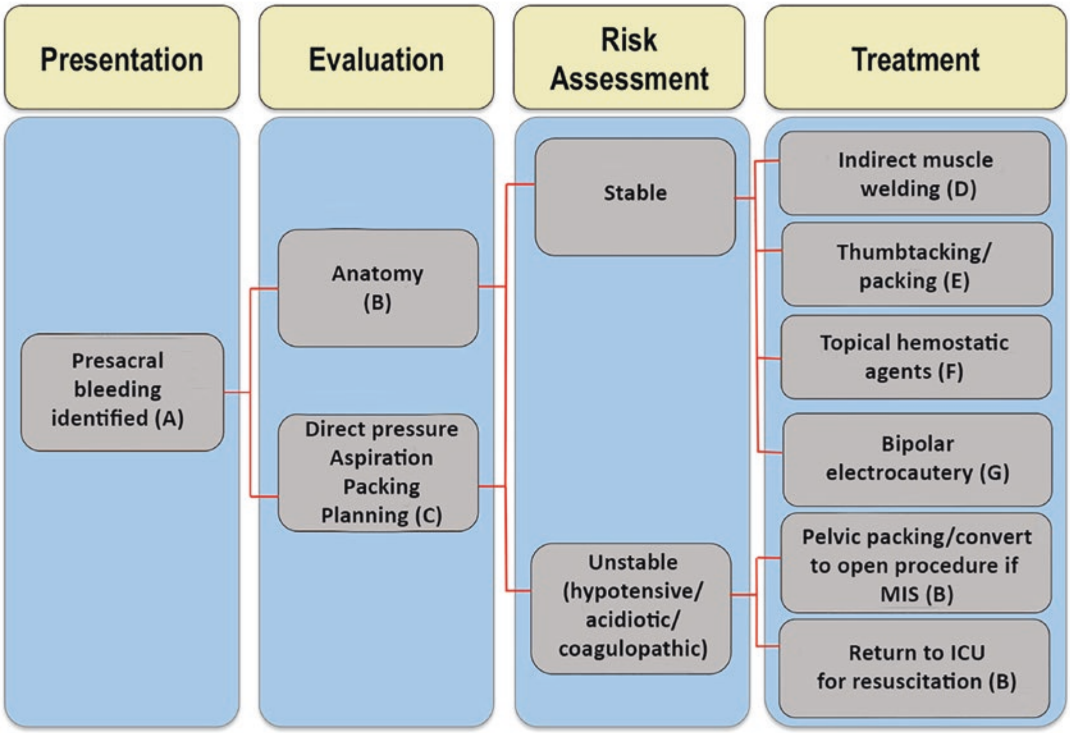

Fig. 89.1 Algorithm for presacral bleeding

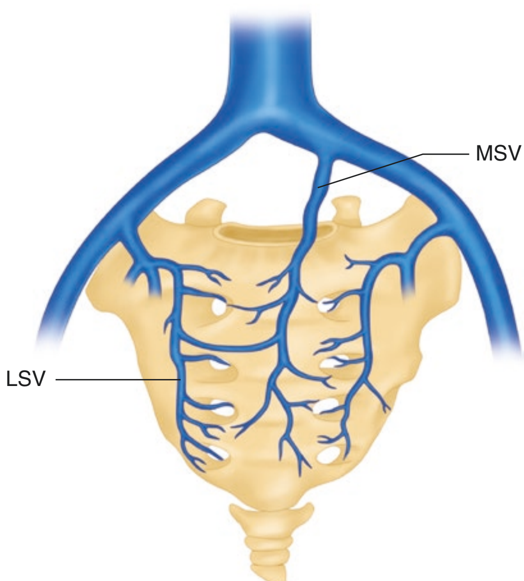

Fig. 89.2 Presacral plexus, *LSV* lateral sacral vein, *MSV* middle sacral vein

most important aspects, in our opinion, is knowing where the tacks are kept in the operating room (as not often used). The thumbtacks come with some drawbacks with reports describing tack dislodgement, chronic pain, and the inability to apply the tacks to bleeding points originating from a sacral neural foramen or near vital structures, i.e. the ureters. They are also ineffective for diffuse hemorrhage.

E. Topical hemostatic agents have also been used for massive presacral bleeding. A combination of Floseal®; (Baxter, Hayward, CA, US) and an absorbable hemostat Surgicel® Fibrillar™; (Ethicon, Somerville, NJ, US) has also been described. The matrix hemostatic sealant is applied over the bleeding site followed by the absorbable hemostat on top as a pad. The pelvis is then packed for temporary hemostasis preventing the sealant from

being washed out. After 3 min, the packs are removed. One newer product EVARREST® Fibrin Sealant Patch; (Ethicon, Somerville, NJ, US) that consists of human fibrinogen and human thrombin embedded in a flexible composite patch component, contains oxidized regenerated cellulose, which adheres to bleeding surfaces and allows for direct pressure. While expensive, it has been shown to be extremely efficacious.

F. Direct electrocoagulation over the bleeding vessel is a well-known ineffective way to control presacral bleeding. Indirect electrocoagulation through a muscle fragment has been well validated and is the preferred technique of these authors to control massive presacral bleeding. A 2 cm × 2 cm segment of rectus abdominis muscle is harvested from the incision and held in place with a forceps over the bleeding area; electrocautery at high setting is then applied to the forceps and transmitted to the muscle fragment, welding the bleeding site. The muscle has the advantage of being soft so it can conform to the bleeding site and pressure can be applied effectively. An epiploic appendage can also be used instead of a muscle fragment if desired.

G. As robotic colorectal surgery becomes more prevalent, the techniques described above need to be slightly adjusted for use with robotics. As previously described, visualization is paramount to all techniques. When using the intuitive *da Vinci*® SI surgical robot this can be achieved with the robotic suction which keeps the field clear and is wristed to help drain areas that a straight suction cannot reach i.e. right below the sacral promontory. If the robotic suction not available or if you are using the *da Vinci*® SI surgical robot, a nasotracheal tube or red rubber catheter can be inserted through a 5 mm trocar and attached to an external suction. This tube can then be directed with one of the robotic arms. Once the accumulated blood has been removed, packing with pressure from one of the robotic arms is a good option, as the robotic arm will provide constant sustained pressure. Surgical robots have a fenestrated bipolar electrocautery arm, which works very well for control and provides less char as compared to monopolar electrocautery. The vessel sealer is also available but recent experiences have found this tool to be less effective than the fenestrated bipolar electrocautery. The safest option when experiencing massive presacral bleeding during a robotic is to convert the procedure from robotic to an open procedure and proceed with the previously described techniques.

H. Massive presacral bleeding is a potentially life-threatening complication of colorectal surgery. Direct pressure and packing should be the first steps allowing for resuscitation and planning. Sacral tacks, if available, are an option, along with multiple hemostatic agents. Indirect coagulation with a small portion of rectus muscle may be the most effective way to control the massive hemorrhage. Using the fenestrated bipolar electrocautery seems to be a promising technique when encountering presacral bleeding during a robotic case after adequate aspiration of accumulated blood. Ultimately, if the above measures fail to stop the bleeding and the patient begins to show signs of coagulopathy, acidosis, or hypotension; the safest step is to pack the pelvis, abort the procedure, and return the patient to the intensive care unit for continued resuscitation.

Suggested Reading

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Complications: Short Gut Syndrome

90

Ramzi M. Helewa and Robin P. Boushey

Refer to Algorithm in Fig. 90.1

A. Short gut syndrome or short bowel syndrome (SBS) is a clinical condition of intestinal failure that usually following extensive resection of small bowel whereby less than 200 cm of residual small bowel remains. Any laparotomy that results in significant or extensive small bowel resection increases patient's risk for SBS. However, the surgeon must recognize that the length of the remaining bowel is only one aspect contributing to SBS. The function of the residual bowel and the presence of the ileocecal valve and colon are integral in the development in SBS. Clinical presentation after extensive bowel resection include inability to maintain proper and adequate nutrition and hydration without intravenous or oral supplementation. Thus, it is imperative at the time of laparotomy for the surgeon to identify patients at risk for SBS, provide informed counseling, and to be aware of the clinical implications of extensive bowel resections.

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B. SBS may be due to multiple laparotomies for Crohn's disease, mesenteric ischemia, radiation enteropathy or enteritis, or due to enterocutaneous fistula. When facing patients undergoing an initial laparotomy, or subsequent laparotomy, for any of the above conditions it is important to highlight the risks and consequences of SBS in order to set realistic patient, family, and care-giver expectations.

C. Patients with Crohn's disease (CD) are at risk for SBS due to multiple operations with extensive bowel resections. This highlights the need for exhaustive multidisciplinary discussions for patients with CD so as to optimize medical therapies prior to considering surgery. At laparotomy, extensive margins are unnecessary as CD recurrence is unaffected by margin width from macroscopically involved bowel. The surgeon also must be cognizant of any fistulizing disease such as entero-colonic or entero-enteral fistulas, as these may decrease the absorptive capacity of the bowel. It cannot be overstated that great care must be exercised in being exceptionally conservative with bowel resections in CD.

D. Enterocutaneous fistula (ECF) can result in complications including fluid/electrolyte imbalance, sepsis, and malnutrition. Loss of the integrity of the bowel and diminished absorptive surface area contribute to overall malnutrition. For a significant proportion of patients with ECF, intestinal failure may

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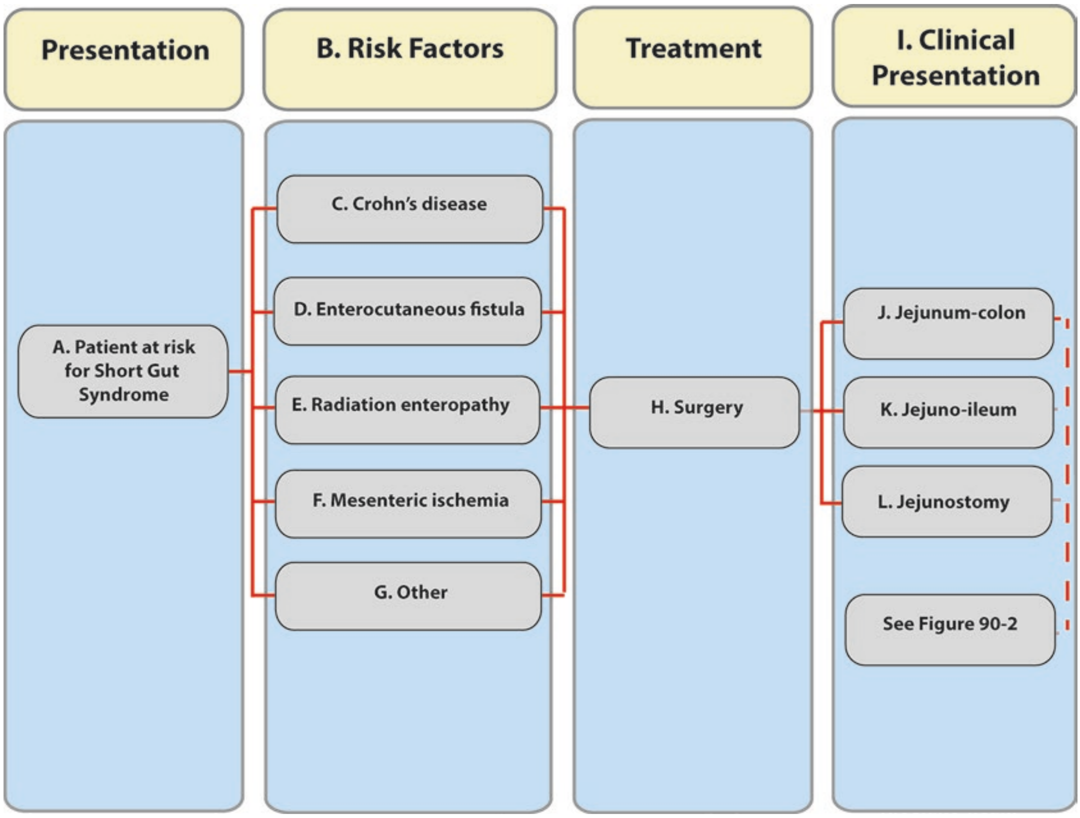

Fig. 90.1 Algorithm for identification of risk factors and clinical presentation of short bowel syndrome

occur due to either attempted surgical repair or the natural history of disease. In order to optimize outcomes, management of fistula output, control of sepsis, and nutritional support are paramount prior to surgery.

E. Radiation enteropathy, or enteritis, can result in SBS as a result of repeated surgical interventions as well as radiation-induced bowel injury causing reduced functional capacity. Surgery may be required due to complications such as obstructive strictures, fistulas, and perforations. Resection or bypass is commonly employed surgical options for patients with radiation-associated strictures. However, when faced with the risk of SBS, one may consider strictureplasty to preserve bowel length, for very well-selected patients.

F. Mesenteric ischemia can be thromboembolic, venous, or non-occlusive in nature. Often emergency surgery, SBS due to mesenteric ischemia may be the result of extensive bowel resection at one setting, converse to CD where patients have multiple sequential laparotomies. Prompt diagnosis and intervention of mesenteric ischemia is paramount. Preoperative treatment involves fluid resuscitation and therapies to reduce sepsis and reperfusion injury. If appropriate, β-adrenergic agonists, intra-arterial papaverine, or glucagon may be considered. At the time of laparotomy, revascularization should be attempted prior to intestinal resection. Non-viable bowel should be resected. Questionable bowel should be re-assessed with a second look laparotomy in 24–48 h. This may avoid unnecessary resection of potentially viable small bowel. Described methods to assess intra-operative bowel viability include visualizing small bowel peristalsis, Wood's lamp examination with IV

fluorescein, and Doppler assessment of the mesentery. Early post-operative anticoagulation with IV heparin should be undertaken, if possible.

G. The etiology of SBS includes, but is not limited, to the above conditions. Other causes of SBS include trauma, small bowel volvulus, and bowel resections for desmoids and other tumors. In pediatric population, SBS may be congenital, such as intestinal atresia, or acquired, including necrotizing enterocolitis or gastroschisis. Functional SBS, severe malabsorption when bowel is intact, may be due to refractory sprue, chronic intestinal pseudo-obstruction, or congenital villous atrophy.

H. At the time of laparotomy, the surgeon must be well aware of the consequences of extensive bowel resection. For instance, the decision to resect the ileocecal valve (ICV) is an important one. The loss of the ICV may increase risk of small intestinal bacterial overgrowth (SIBO) leading to nutrient malabsorption. SIBO can result in gastrointestinal bleeding, malnutrition, inflammation, translocation of bacteria, and D-lactic acidosis. Conversely, some authors have shown that ileocolonic transit time does not differ after right hemicolectomy. Similarly, SIBO may be influenced more by remaining small bowel length rather than colon length or presence of ICV. Despite the controversy, the surgeon must have an appreciation as to the merits of preserving the ICV. Our preference is to preserve the ICV when possible.

The ability to preserve colon in continuity with remaining small bowel at the time of laparotomy is also important. After small bowel resection, the colon can adapt to increase absorptive surface as well as salvage malabsorbed carbohydrates through carbohydrate fermentation as an energy source. With an intact colon in continuity, a small bowel length of 50–70 cm may be sufficient to allow a return to enteral feeds. However, there may be risks of D-lactic acidosis and hyperoxaluria. Still, when patient characteristics permit, our practice is to perform a small bowel to colon anastomosis.

Additionally, it is critical that the surgeon document the length and nature of the remaining bowel. This is important to help guide future interventions as well as to help guide post-operative management.

I. The clinical spectrum of malnutrition, dehydration, electrolyte abnormalities and weight loss in SBS is contingent upon the residual bowel left in-situ post resection. The surgeon should be aware of the basic physiological bowel functions. The jejunum is responsible primarily for absorption of protein, carbohydrates, and fat. When resected, digestive enzymes are up-regulated and absorptive surface area increases of the remaining bowel in order to compensate. The ileum mainly absorbs bile salts and vitamin B12. Loss of greater than 60 cm of ileum can results in B12 malabsorption, while a loss of greater than 100 cm results in steatorrhea and deficiency in fat-soluble vitamins and bile salt.

Patients with a jejunostomy also lack the inhibitory feedback mechanism to slow gastric emptying as the cells that release the GI hormones involved in this process (e.g. glucagon-like peptides, peptide YY, and neurotensin) are found in the terminal ileum. The ileum absorbs sodium through an active transport system while the jejunum's sodium absorption is passive, through osmotic gradients. Therefore, severe dehydration may occur in patients with jejunostomies.

Cholelithiasis due to disruption of the entero-hepatic circulation happens frequently. As well, nephrolithiasis due to hyperoxaluria is common as well.

Other clinical presentations of SBS include slurred speech and mental confusion. This may be the result of magnesium or thiamine deficiencies or hyperammonemia.

There are three broad categories of patients with SBS. This includes patients with jejunum-colon anastomosis, jejuno-ileum anastomosis, and those with a jejunostomy.

J. Jejunum-colon anastomosis after extensive jejunoileal resection results in steatorrhea and diarrhea. Despite initially appearing clinically well, over time these patients suffer from weight loss and severe malnutrition.

Confusion, slurred speech, and severe ataxia may result in patients with an intact colon and SBS. This is the result of unabsorbed carbohydrates undergoing fermentation in the colon to produce D-lactic acid, which subsequently gets absorbed systemically.

K. Jejunum-ileum patients have more than 10 cm of the terminal ileum and colon left in-situ after jejunal resection. These patients are rare and infrequently manifest SBS. Supplemental parenteral nutrition is rarely required unless the remaining bowel has compromised absorptive capacity such as in radiation enteropathy or CD. When encountered however, they are often have diarrhea after meals and are managed similarly to Jejunum-colon patients.

L. Jejunostomy patients have an end-jejunostomy after jejunoileal resection and colectomy. They present with immediate dehydration due to major sodium and water losses. Jejunostomy and Jejuno-colon patients are the most commonly encountered in SBS.

Refer to Algorithm in Fig. 90.2

A. The diagnosis of SBS usually apparent as patients have significant malabsorption. As above, documentation of remaining bowel at time of laparotomy is important. If not noted intra-operatively, then post-operative contrast studies may be useful. Post-absorptive plasma citrulline levels can also be used as a marker for residual functional bowel length and is a predictor for determination of permanent versus transient SBS.

B. The management of SBS is complex and involves a number of different specialists including surgeons, gastroenterologists, dieticians, psychologists, and nursing support. As such, an integrated, multidisciplinary team, working at a specialist center may be best equipped for treating patients with SBS. Management can be considered to be immediate/early post-operative or long-term. At the core of this is a multi-disciplinary team platform by which patient concerns and

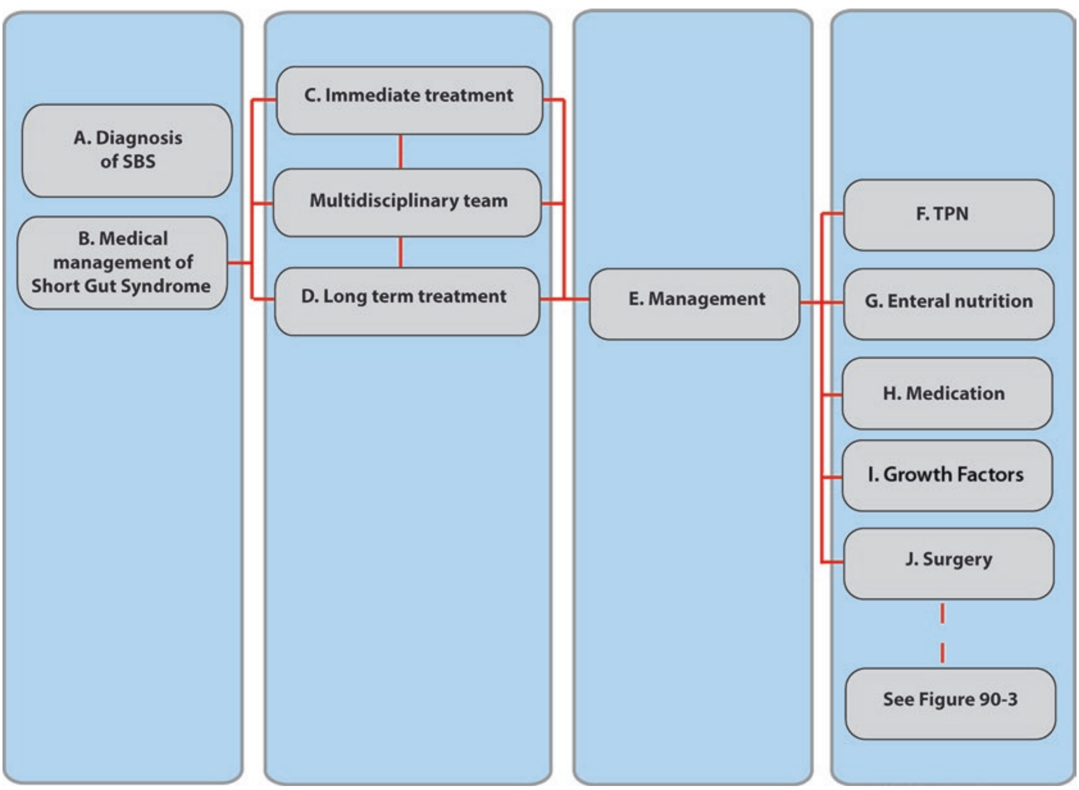

Fig. 90.2 Algorithm for management of short bowel syndrome

issues can be addressed in a timely fashion so as to avoid major complications due to SBS. Overarching goals are to return the patient to a good quality of life.

C. Immediate treatment in the post-operative setting is aimed at preventing early complications. Early goals are aimed towards maintaining hydration and avoiding malnutrition with early enteral or parenteral nutrition use. Patients often present with significant thirst, renal failure, and hypotension. As such, body weight, fluid balance, and serum electrolytes should be measured frequently. Accurate measurement of fluid balance with gastrointestinal losses is important as depletion of water, sodium and magnesium is common in patients with a jejunostomy. Overall nutritional status may be determined by body mass index (<18.5 km/m^2), percentage of weight loss, mid-arm muscle circumference, or serum albumin. However, one must not overlook the role of nutritional supplementation in the immediate post-operative period, such as the early use of total parenteral nutrition (TPN).

D. Intermediate to Long-term treatment involves nutritional supplementation, either parenteral or enteral, and medications to decrease fluid losses, increase absorption of nutrients, and improve intestinal adaptation. Intestinal adaptation, or rehabilitation, is the mainstay in the long-term treatment of SBS. This process involves medical, dietary, and surgical strategies to restore enteral autonomy and allow weaning from parenteral nutrition.

E. The management of SBS is multifaceted with different treatments used in tandem or simultaneously. Overall goals are to improve quality of life, prevent major complications, and to stimulate intestinal rehabilitation or adaptation. As such, treatment is individualized for each patient.

F. Total Parenteral Nutrition (TPN) is the used as the first line nutritional supplement after surgery. It provides essential fluid and nutritional support to help assist with intestinal adaptation. For a subset of patients, TPN may be life-long. Since complications can occur with TPN, a balance should be reached in order to help support the patients while minimizing risk of complications.

TPN prescription is beyond the scope of this chapter. However, briefly, the composition of TPN should be made based on weight, age, and nutritional requirements. Overall caloric goals should be for the patient to attain 25–30 kcal/kg/day. This is accomplished using dextrose for carbohydrates, amino acids for proteins, while lipids should account for 20–30% of energy requirements. Protein should requirements are 1.0–1.5 g/kg/day. For patients unable to tolerate enteral/oral nutrition, then micronutrients, for example zinc and selenium, should be supplemented with the TPN. Vitamin B12 and thiamine may also be supplemented as well. The exact composition of these micronutrients is contingent upon underlying medical comorbidities such as hepatic or renal dysfunction. Furthermore, liver steatosis and hyperinsulinism may be minimized by delivering TPN in a cyclical infusion.

Many centers have pharmacists whose focus is on TPN. Assistance with such specialists is helpful when facing patients for long-term TPN therapy. This is especially true when considering that for well-selected patients with chronic SBS, home parenteral nutrition (HPN) can be provided. It is more cost effective than in-hospital TPN.

Attempts to wean patients from TPN can be undertaken if they can tolerate enteral/oral nutrition in order help with intestinal adaptation. Failures of these efforts are often seen when patients have less than 50 cm of bowel remaining and having had the ICV resected. Attempts of TPN-weaning are warranted as around half of patients on HPN may become independent from it. Success is more common in patients with a jejuno-ileocolic anastomosis and less likely for jejunostomy patients.

Many complications from long-term TPN exist including sepsis, vascular access loss such as due to thrombosis or dislodgement, metabolic complications, renal dysfunction, metabolic bone disease, biliary complications such as acalculous cholecystitis and

cholelithiasis, and liver disease such as cirrhosis and liver failure. Strategies to reduce liver dysfunction with TPN are to avoid excessive dextrose feeding, sepsis, limit intake of omega-6-rich long chain triglyceride lipid emulsions, and improve enteral intake. One must have an appreciation for the complications associated with long-term TPN and all attempts should be made to transition to oral/enteral feeds if possible.

G. Overall goals with SBS are to return to a state in which the patient can attain all required nutrition and hydration enterally. Given the multitude of risks associated with TPN, all efforts are made to transition to oral or enteral feeds. Benefits of enteral nutrition include the promotion of intestinal adaptation and hyperplasia of the intestinal mucosa, therefore increasing functional capacity and absorptive surface area to meet metabolic needs. In the early postoperative period, continuous enteral feeds are given via nasogastric or gastrostomy tubes. Transition to oral feeds is gradual.

Enteral feeds should be individualized, taking into account patients remaining bowel length and other medical comorbidities such as renal failure. For proximal jejunostomies, an elemental diet can be considered, but these are often hyperosmolar and may worsen diarrhea. Additionally, patients should limit oral hypotonic fluids (water, juice, coffee) to less than 500 ml per day. To meet the remaining fluid requirements, patients should drink a glucose-saline solution (greater than 90 mmol/l of sodium).

Strategies to improve caloric intake in patients with a retained colon involve using a diet that is low in fats but high in carbohydrates. The colon can salvage unabsorbed carbohydrates through carbohydrate fermentation. However, there is a risk of D-lactic acidosis if the diet is rich in mono- or oligosaccharide carbohydrates.

In unique situations in which the patient has a mucous fistula or a high output ostomy/fistula with an accessible distal limb, fistuloclysis may be an option. In this situation, enteral nutrition is provided using a feeding tube into the distal bowel. For selected patients, fistuloclysis may improve nutritional status or even replace TPN.

H. A trial of antisecretory medications, such as H2 Blockers and Proton Pump Inhibitors (PPI) may decrease ostomy output by decreasing gastric acid secretion for patients with SBS. For instance, omeprazole has been shown to decrease ostomy output but does not obviate the need for parenteral support. H2 Blockers and Proton Pump Inhibitors (PPI) are mainly useful during the first year following resection.

Loperamide and codeine are also useful adjuncts for decreasing intestinal motility and lower sodium and water losses by up to 30%. Loperamide is the preferred agent as is non-addictive and does not impair fat absorption. Higher doses of loperamide may be needed for patients with SBS, as it circulates through the enterohepatic circulation. Loperamide is given prior to meals. Lomotil is another agent often used, but its anticholinergic side effects, such as dry mouth, may not be preferred. Strategies to improve oral absorption of these medications are to crush or open them into water or food especially if they are found undigested in stool or stoma output.

Octreotide may also decrease also ostomy output, but has been shown in rat models to inhibit cell proliferation and intestinal adaptation. For patients with a proximal jejunostomy, transdermal clonidine, an alpha2-adrenergic agonist, may also be considered as it results in decreased fecal sodium loss as well as have a modest decrease in stoma output.

Cholestyramine may be used in patients with bile acid malabsorption (BAM), a secretory diarrhea after ileal resection. Mechanism of action involves binding unabsorbed bile salts. Dosing is started at 4 g twice per day. Side effects include nausea, flatulence, abdominal pain, and bloating. Additionally, it may interfere with absorption of fat-soluble vitamins.

I. With a goal being intestinal adaptation and rehabilitation, growth factors may have a role in enhancing this process. However, studies are limited and conflicting. For example, growth hormone has shown controversy in the literature with regards to absorptive capacity improvement. Additionally, oral glutamine with a high-carbohydrate, low fat diet has not shown to be effective over placebo for intestinal transit and morphology. Conversely, recombinant human growth hormone, oral glutamine, and enteral nutrition for 4 weeks has resulted in improved intestinal absorptive capacity, plasma protein levels, body weight, total body water, and lean body mass.

Glucagon-like peptide-2 (GLP-2), which is secreted by endocrine L-cells, acts to increase absorptive capacity and improved intestinal energy absorption, and increased body weight. A recombinant human GLP-2 analog with extended half-life, teduglutide, has a number of beneficial outcomes including increased plasma citrulline levels, structural intestinal adaptation of villi and crypts, increased nutrient, energy, and fluid absorption, as well as reduced TPN and intravenous fluid dependence. Low dose teduglutide also has been shown reduce TPN requirements relative to placebo. Improvements in mental function quality of life of short form 36 (SF-36) and overall patient satisfaction is seen with long-term therapy of GLP-2. Side effects include nausea, abdominal pain, and distension.

Other growth factors that have been evaluated in animal models include insulin-like growth factor (IGF-1), epidermal growth factor (EGF), leptin, testosterone, thyroxine, and glucocorticosteroids. Further research is required in this domain.

J. Surgical management in SBS may have a role in increasing absorptive capacity of and perhaps reduce nutritional support. Options are numerous including non-transplant surgical options such as restoration of gastrointestinal continuity, surgeries to lengthen bowel or slow transit through the GI tract, and intestinal transplant.

Refer to Algorithm in Fig. 90.3

A. The use of non-transplant surgical options to increase fluid and nutrient absorption has been underestimated and underutilized. Surgical intervention for SBS is contingent on numerous factors, including temporal relationship to prior laparotomy, presence of intra-abdominal sepsis, length and quality of remaining small bowel and colon, underlying medical comorbidities, and patient's response and tolerance to nutritional and medical supports. All these factors have to be considered as surgical interventions are aimed to reduce severity of and complications from SBS and to avoid worsening the situation. Overall, surgical options can be thought of in two categories—either non-transplant surgery or transplant surgery. Choice of non-transplant surgery depends on the ability to restore gastrointestinal (GI) continuity and the presence of dilated residual bowel.

B. In situations in which the patient has an ostomy with residual distal bowel that is defunctioned, the option may exist to reverse the ostomy and restore GI continuity. However, it must be emphasized that the patient must be optimized medically with regards to nutritional status and comorbidities. Consideration and appreciation must be given to the underlying medical condition that initially resulted in the patient developing SBS. Sufficient time must have passed since the last laparotomy to minimize intra-abdominal adhesions. If possible, patients should also undergo endoscopic or radiographic evaluation of the distal bowel remnant to rule out a distal obstruction. Small bowel to colon anastomosis can improve electrolyte and fluid absorption and even wean patients off of TPN. Again, the surgeon must be aware of the risks of D-lactic acidosis in this situation.

C. If restoring GI continuity does not result in the ability to wean off TPN, slowing GI transit may maximize available absorptive capacity by increasing the amount of the time that luminal contents are in contact with the GI

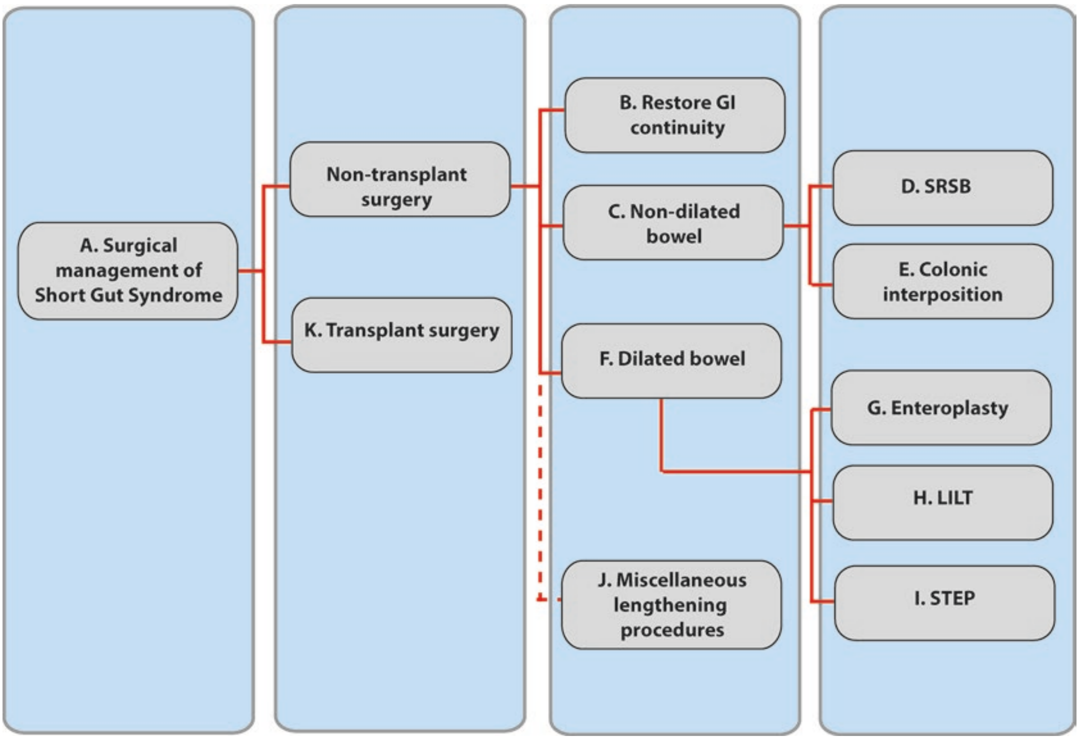

Fig. 90.3 Algorithm for the surgical management of short bowel syndrome. *LILT* longitudinal intestinal lengthening and tailoring, *STEP* serial transverse enteroplasty

tract. In the absence of bowel dilatation, one can consider segmental reversal of the small bowel (SRSB) or isoperistaltic colonic interposition.

D. SRSB involves creating a 10–12 cm anti-peristaltic portion of bowel approximately 10 cm proximal to stoma or entero-colonic anastomosis. It has been demonstrated that it is a viable alternative to small bowel transplantation, with nearly half of patients being able to be weaned from TPN. Intra-operatively, a complete volvulus must be avoided by only rotating proximal bowel and distal bowel by 90° so that the mesenteric rotation approximates 180°.

E. Isoperistaltic colonic interposition involves placing a segment of colon in between small intestine. Limited studies exist in the pediatric population. Given successful outcomes seen with other modalities, this should only be considered with great caution.

F. With the presence of dilated bowel, several options exist to improve intestinal motility including enteroplasty and operations to increase the functional surface area of the bowel.

G. Rapid GI transit is a challenge in SBS and investigations should look for underlying, reversible structural issues. Patients with SBS and rapid transit in the setting of segmental small bowel dilatation and poor peristalsis may result in SIBO. Excessive dilatation of the bowel may be amendable to a tapered enteroplasty. Often used in pediatric surgery, a stapler is used to excise a rim of small bowel along the antimesenteric border of the intestine. The choice of enteroplasty is considered when the loss of surface area is favored over better peristalsis.

H. When bowel length is important, a longitudinal intestinal lengthening and tailoring (LILT) procedure, also known as the Bianchi operation, allows for preservation of absorptive surface area while allowing for intestinal tapering. In this procedure, the mesenteric leaflets are split in the avascular space in the

area of dilated bowel. The dilated small bowel is then stapled longitudinally while preserving blood supply. Each half of the tubularized bowel is then anastomosed in an isoperistaltic fashion, thus doubling the length of the original bowel while preserving absorptive surface area. Over time, the bowel may dilate and absorptive capacity may increase. Patients with advanced liver disease should not undergo bowel lengthening procedures.

I. Another surgical option for patients with dilated small bowel is the serial transverse enteroplasty (STEP), which allows for tapering while preserving surface area. It involves narrowing of the lumen by firing series of linear staplers perpendicularly, in a zigzag fashion, along the length of the bowel. It has been shown to reduce dependence on TPN and increase length of the bowel.

J. Other treatments may involve procedures to increase mucosal surface area such with controlled tissue expansion (CTE), creation of intestinal valves, or implantation of reversed electrical pacemaker devices, and spiral intestinal lengthening and tailoring (SILT). However, experience is limited and consideration must be given for more robustly researched alternatives.

K. Intestinal transplant is an option for patients who have not had success with intestinal adaptation or who have failed TPN or are at risk of major complications. The US Centers for Medicare and Medicaid Services (CMS) have defined TPN failure criteria (Table 90.1). Contraindications to transplant include malignancy and active infection. Transplant may include isolated intestinal transplant including the right colon, but if there is advanced liver disease, a combined liver-intestinal transplant with multi-visceral transplantation may be required. Combined liver-intestine transplant patients have a higher relative risk of dying relative to isolated intestinal transplant while on wait list as well as have a lower odds of receiving a transplant. These factors highlight the need for early referral for patients who fail TPN, prior to the development of significant liver dysfunction. In the past, high rates of morbidity and mortality influenced the choice of transplantation as an option. However, outcomes after transplant are improving with developments in newer immunosuppression medications. Early referral to a transplant center is important in optimizing patient outcomes.

Table 90.1 Definition of TPN failure

• Liver failure due to TPN induced liver injury
– Elevated liver enzymes, elevated serum bilirubin, splenomegaly, varices, thrombocytopenia, coagulopathy, or cirrhosis
• Thrombosis of central venous access
– Subclavian, jugular, and femoral veins
– Loss of 2 of these vessels is a life-threatening complication
• Frequent line sepsis
– Two or more episodes of line infection per year that results in hospitalization
– Single episode of fungemia, septic shock, or ARDS related to vascular access
• Recurrent dehydration despite IV fluids and TPN

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Complications: Surgical Site Infections

91

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Refer to Algorithms in Figs. 91.1 and 91.2

A. **Background/Definitions**:

As a whole, complications following colorectal surgery are quite common. Even though nationally, colorectal procedures represent only 10% of all procedures performed, they account for up to 25% of all complications. Surgical site infections are one of the most common problems encountered after colorectal surgery. Estimates are that two-thirds of infections are due to an incision (i.e., superficial) while one-third is within the sub-fascial tissue (i.e., deep or organ space). Overall rates of colorectal SSI vary widely, but commonly reported rates range from 3.7% to 34%, with most estimates reported in the 5–10% range. These infections can be quite costly, with relative costs 1.43-fold higher for those with an infection. Estimated *additional* charges range from $7000 to more than $25,000 to treat these infections beyond what is required for usual care, with higher costs associated with deep or organ space infections.

Definitions of various types of surgical site infections may also vary widely in the literature. This makes comparisons between studies difficult. A standardized definition used by the Centers for Medicare and Medicaid Services (CMS) by the National Healthcare Safety Network is shown in Fig. 91.2. Review of these definitions reveals they are quite broad. There are several ways in which a wound may qualify for SSI and this makes tracking the process difficult. There may be marked inter-observer variability in determining the presence or absence of infection. CDC definitions tend to result in higher reported rates than those seen in the National Surgery Quality Improvement Project database (NSQIP).

B. **Reimbursement Penalty**

CMS has implemented what equates to a "pay for performance" measure for surgical site infections following colorectal procedures (Fig. 91.3). This is tied to a broader plan to penalize any incidence of hospital acquired conditions or infections (HAC & HAI, respectively). Beginning in 2016 and increasing over the next few years, providers may be subject to up to a 9% reimbursement penalty for poor performance and high incidence of SSIs. This has prompted many institutions to implement bundled care plans to try and

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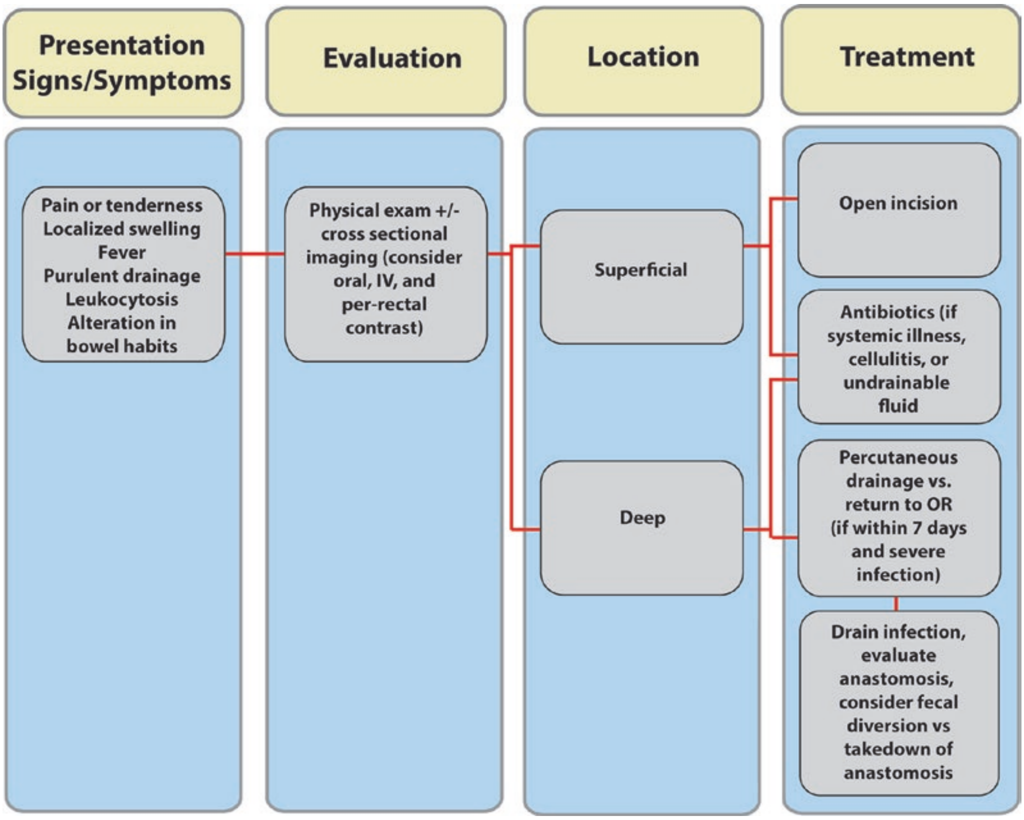

Fig. 91.1 Algorithm for Surgical site infection

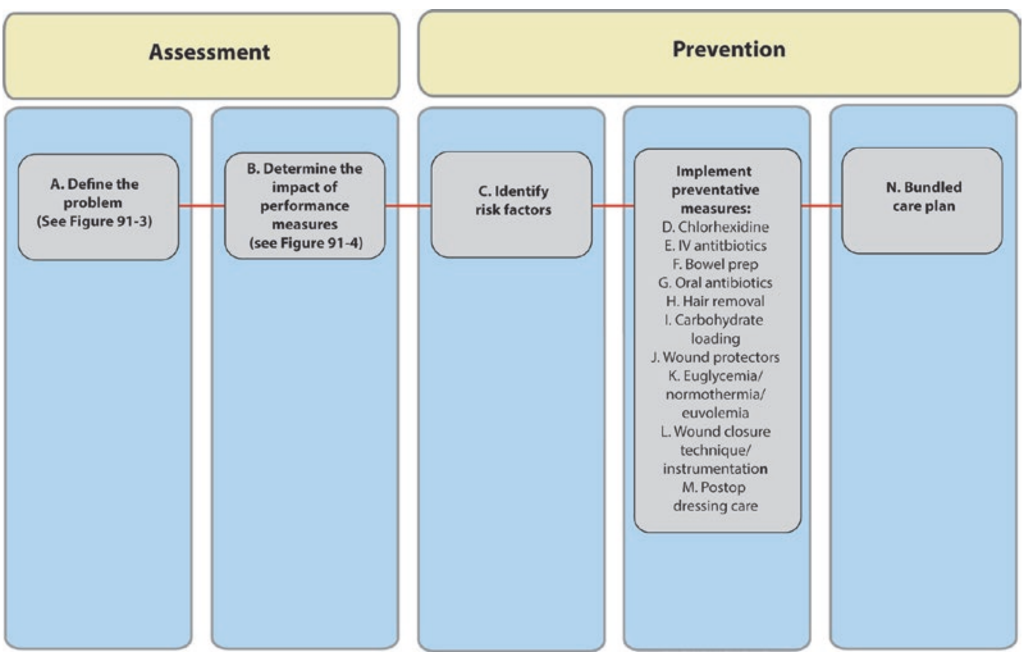

Fig. 91.2 Algorithm for assessment and prevention of surgical site infections

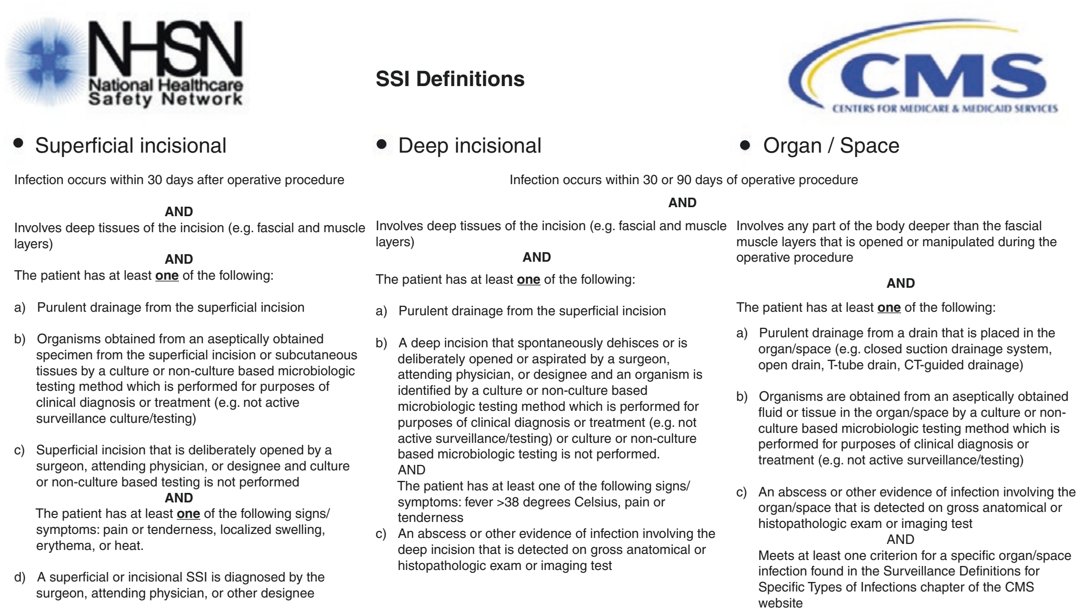

Fig. 91.3 A standardized definition used by the Centers for Medicare and Medicaid Services (CMS) by the National Healthcare Safety Network. Adapted from: https://www.cdc.gov/nhsn/pdfs/pscmanual/9pscssicurrent.pdf

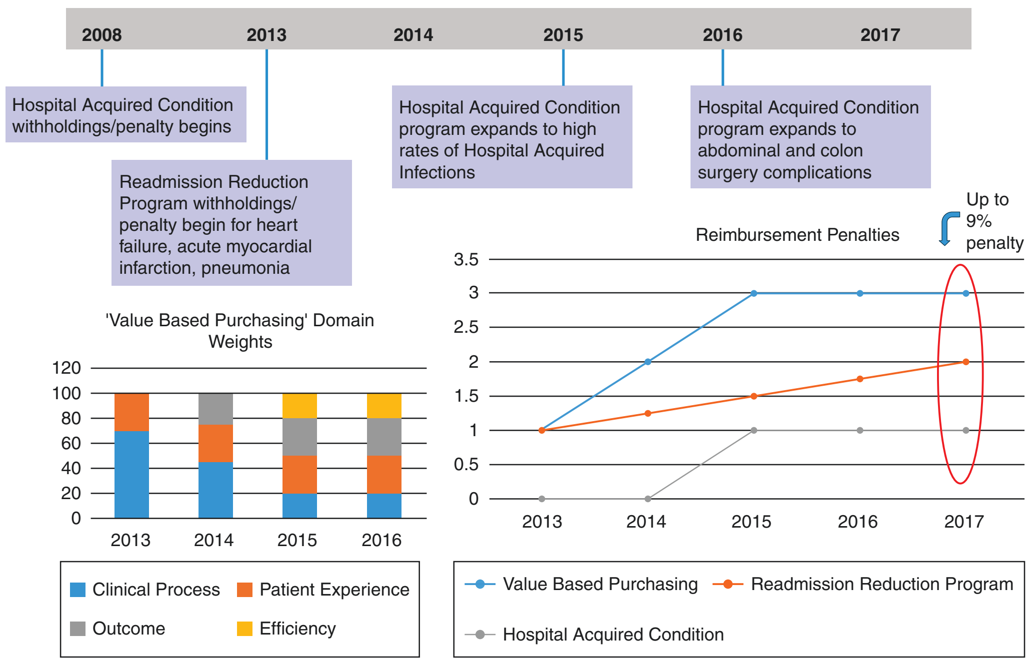

Fig. 91.4 Timeline and impact of pay for performance measures

decrease the incidence of these infections. Use of these bundles may reduce SSI rates by 50% or more. What follows is a description of various components within these bundles and the evidence behind it. In 2016, CMS is only tracking deep or organ space infections to calculate this penalty. Superficial infections are currently excluded (Fig. 91.4).

C. **Risk Factors**

It is well known various risk factors may predispose a particular patient to develop a surgical site infection. Common risk factors are shown in Table 91.1. An additional factor is a description of the wound class. Standard definitions of wound classification (i.e., clean, clean-contaminated, contaminated, infected/dirty) are shown in Table 91.2. These have been widely adapted from the original American College of Surgeons wound classification schema. The proper identification of wound class is critical as it changes the observed to expected rates of infection, which is also used to benchmark performance. Accepted incidence of SSI according to each wound classification is also listed in Table 91.2.

D. **Chlorhexidine vs. Povidone-Iodine**

Use of alcohol-based skin preparation solutions have shown to significantly decrease rates of surgical site infections. A randomized trial demonstrated SSI rates of 9.5% vs. 16.1% ($p = 0.004$, RR 0.59) in patients undergoing clean-contaminated surgery. This reduction was seen for both superficial and deep infections. As a result, chlorhexidine based solutions are now widely recommended for best practice over povidone-iodine solutions. This concept can also be applied preoperatively, with the use of chlorhexidine showers or wipes applied to the surgical site at home prior to arrival at the hospital for surgery.

E. **Parenteral Antibiotic Prophylaxis**

Much attention has been given to appropriate antimicrobial prophylaxis prior to skin

Table 91.1 Patient and operative risk factors associated with SSI

Patient risk factor	Operative risk factor
Age	Duration of surgical scrub
Nutrition status	Preoperative skin preparation
Diabetes	Preoperative shaving (vs. clipping)
Smoking	Duration of operation
Obesity	Antimicrobial prophylaxis
Colonization	Operating room ventilation
Immunosuppression	Instrument sterilization
Length of stay	Foreign material in surgical site
ASA class	Surgical drains
Steroid use	Inadequate hemostasis
Radiotherapy	Tissue trauma
	Perioperative transfusion

Table 91.2 Classifications of wounds

Wound classification	Description	Expected SSI rate
Clean	Uninfected wound with no inflammation. Respiratory, alimentary, genital, or uninfected urinary tracts are not entered.	1–5%
Clean-contaminated	Controlled entry into respiratory, alimentary, genital, or urinary tracts without unusual contamination. This includes biliary tract, appendix, vagina, and oropharynx procedures. No major breaks in sterile technique.	3–11%
Contaminated	Open, fresh, accidental wounds. Major breaks in sterile technique (e.g. gross spillage from gastrointestinal tract). Acute, non-purulent inflammation encountered (including necrotic tissue such as dry gangrene).	10–17%
Dirty or infected	Old, traumatic wounds with retained devitalized tissue or existing clinical infection or perforated viscera. This suggests that organisms causing postoperative infection were present in the operative field before the operation.	>25%

Adapted from www.cdc.gov/hicpac/SSI/table7-8-9-10-SSI.html

incision. The ideal antibiotic for colorectal procedures would cover both skin flora and enteric organisms. Antibiotic concentrations should be at appropriate levels throughout the procedure, and redosed as needed. Appropriate prophylaxis can reduce SSI rates by up to 75%. While the SCIP measures are no longer "enforced", there remain antibiotics that have lower rates of infection vs. others. Evidence based studies have shown that the use of cefazolin + metronidazole, ertapenem, and ceftriaxone + metronidazole (or fluoroquinolone + metronidazole for penicillin allergic patients) result in lower infection rates vs other antibiotics. The additional cost of single-administration antibiotics may be offset by the reduction in overall rates of infection. It is also important to keep in mind the need for appropriate re-dosing for longer cases and those associated with increased blood loss.

F. **Mechanical Bowel Preparation**

The use of mechanical bowel preparation has been the subject of much debate in recent years. Randomized trials, meta-analyses, as well as several Cochrane reviews have not been able to show a significant difference in surgical site infections or leak rates. However, the majority of colorectal surgeons continue to use a mechanical bowel preparation, particularly for left-sided or laparoscopic procedures. There may be other advantages such as the potential need for endoscopic intervention/lesion localization, improved handling of a stool-free colon (particularly for laparoscopic cases) as well as avoidance of a column of stool above a defunctioned anastomosis. The topic remains controversial and may be left up to surgeon preference. However, what seems clear is that when chosen, oral antibiotics should be used as well (see G).

G. **Oral Antibiotics**

Nichols and Condon first described use of oral antibiotics for preparation in 1973. This practice fell out of favor, but recently has seen a resurgence. The most recent evidence (including randomized trials) suggests there may indeed be a reduced surgical site infection with the use of these preparations compared with mechanical preparation alone, though there may not be a reduction in anastomotic leak rates. A contested topic is whether this results in higher rates of *Clostridium difficile* infection. If it does, the evidence suggests any such increase is small (if at all), though several recent studies have demonstrated no increase.

H. **Clipping vs. Shaving Hair Removal**

Preoperative shaving can result in microscopic or gross damage to the skin. As a result, the integrity of this important barrier is broken and can lead to higher infection rates in deeper tissues. Clipping of hair ensures that no damage is done to the skin surface by a razor blade and has been consistently recommended to decrease surgical site infection rates. This should be performed right before the operation and not hours or days ahead.

I. **Preoperative Fasting and Carbohydrate Loading**

One of the guiding principles of enhanced recovery after surgery (ERAS) is to minimize the physiologic stress of surgery on the body and minimize interruptions in normal activity. The practice of keeping patients NPO after midnight may work against this, particularly for afternoon operations. As a result, the American Society of Anesthesiology guidelines recommend the use of clear liquid diet with fasting times of 2–4 h prior to a surgical procedure. There is level 1 evidence that suggests this results in lower gastric volumes and higher pH levels compared with fasting >4 h. The volume of liquid is less important than the type of liquid.

Similarly, surgery incites a catabolic response. Preoperative carbohydrate loading may prepare the body better for surgery, just as high performance athletes would before a competition or event. The use of these strategies may result in decreased recovery times. However, this does require some clarification, as many sports drinks use a high proportion of

simple sugars (e.g., fructose) that may result in perioperative hyperglycemia. The risk of postoperative hyperglycemia can also result in increased rates of SSI by as much as 30% for each 40-point increase above normoglycemia. Several commercially available products use maltodextrin may lower this risk, by blunting gluconeogenesis for as long as 72 h postoperatively. These drinks are becoming increasingly prevalent in enhanced recovery protocols.

J. **Wound Protectors**

Plastic wound protectors have become widely available and use a physical plastic barrier to protect the skin and subcutaneous tissues during surgery from any contamination. They may also provide some self-retaining retraction of the wound. While the theory is good, and studies show decreased wound bacterial counts with use of these protective barriers, this has historically not translated into any clinically demonstrable difference in SSI rates. Newer data from randomized controlled trials and systematic reviews, however, suggests that these wound protectors may have a benefit. A randomized trial of laparotomy patients had a SSI reduction from 19.1% to 9.9% ($p = 0.002$). A meta-analysis that included a subset evaluation of colorectal surgery patients saw a risk ratio of 0.65, with larger reductions seen in contaminated vs. clean-contaminated cases. With this new data, it is increasingly clear these barriers may have a beneficial effect, particularly in open, contaminated cases. In laparoscopic cases, use may make self-retaining retraction (for specimen extraction) easier, with the added benefit of protecting the wound. If a hand assist approach is used, these devices are already a built-in part of this technique.

K. **Anesthesia Factors**

A number of anesthesia-related factors are also important to measure. Maintenance of euglycemia and normothermia should be maintained throughout the perioperative period. Patients should have a glucose level checked preoperatively and anyone with elevated levels may require further intra-operative monitoring. Patients without any history of hyperglycemia do not need further investigation. Use of warming devices should be used liberally to prevent hypothermia. Fluids may either be goal directed (with use of esophageal Doppler, or other non-invasive technologies) to maintain stroke volume variation of <12%. All other measures of euvolemia (including urine output, heart rate, central venous pressure, etc.) have been less reliable indicators of volume status. If monitoring technologies are not used, a standard crystalloid infusion of 1000 mL/h for open and 500 mL/h for laparoscopic cases is recommended.

L. **Wound Closure**

It is recommended to change gloves and instruments after the contaminated portion of the procedure (e.g., anastomosis). This allows clean instruments and gloves to be used for the fascial closure portion of the procedure. While the evidence is poor, use of this strategy is cheap and may have some potential benefit. Similarly, the use of an additional cleansing solution within the wound and subcutaneous tissue prior to skin closure may be considered, though there is no good evidence to support routine use. Neither the method of suture closure (e.g., interrupted vs continues) nor the type of skin closure (stapled vs. sutured) seems to have any effect on subsequent SSI rates.

M. **Dressing Care**

The application and management of dressings has been a subject of much debate. Similar to the preferred method of anastomosis—the perfect dressing has suffered from much dogma and little evidence. The ideal dressing would absorb any fluid away from the skin, have a low profile, be easy to change if needed, minimize the incidence of seroma or hematoma, and provide protection from trauma to the wound. A recent Cochrane review examined the effect of dressing on the incidence of wound infections. While there are numerous methodological flaws in many of the studies, no clear evidence was found that any particular type of dressing decreased the incidence of

Table 91.3 A typical "bundle" to reduce surgical site infections may consist of the following elements

Preoperative	Intra-operative	Postoperative
Chlorhexidine shower/wipes	Glove +/− gown change before fascial closure	Sterile dressing maintained for 24–48 h, then removed
Oral +/− mechanical bowel prep	Dedicated fascial closure instruments (clean)	Daily cleansing of incision
Appropriate IV antibiotics within 1 hour of incisions	Wound protector use	Enhanced recovery protocol management
Clipping (not shaving)	Limited OR traffic	
Clear liquids up until 2 h before surgery, carbohydrate loading	Normothermia/Euglycemia	
	Goal directed fluid therapy	

SSI. An evolving field is the use of negative pressure dressings, such as Prevena™ (Acelity Companies, San Antonio, TX). In general, these studies must be interpreted with caution as many are industry sponsored. The results are mixed and the true benefit of these dressings remains to be determined. General recommendations (that are not based on high level evidence) include:

1. The operative dressing should be removed within 48 h of operation (given epithelialization occurs within 24 h).
2. After dressing removal, some form of daily cleansing should be applied (shower, chlorhexidine wipe or sponge).
3. If repeat dressing is re-applied after removal, it should be changed at least daily or when visibly soiled (whichever is more frequent).
4. The type of dressing may be left up to the discretion of the surgeon (gauze + tape, Tegaderm, vacuum) keeping in mind costs and bundle/practice patterns of the institution.

N. **Bundle**

These recommendations can be put together in a standard "bundle" (see Table 91.3) that includes standardized/computerized order sets, ongoing education of providers including nurses and physician extenders, continual measurement of metrics and re-adjustment of protocols to increase compliance, and feedback to providers on performance measures. Creation of low surgical site infection rates is a process that does not happen immediately. CMS is likely to adjust metrics in the future, so cooperation and re-alignment of these goals to match performance measures is key to ensuring ongoing success and to prevent downward reimbursement adjustments.

Suggested Reading

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92 Ileal J Pouch Complications

Pasha J. Nisar and Ravi P. Kiran

Refer to Algorithms in Figs. 92.1, 92.3, and 92.4

A. Pouch failure is defined as the need for permanent diversion of the pouch or pouch excision. In some large series, which include outcomes following IPAA creation for several diagnoses, the failure rate is approximately 4% at 5 years and 7% at 10 years. Factors associated with failure include pelvis sepsis, anastomotic leak, pouch fistula, poor pouch function and development of Crohn's disease (CD).

B. Modifiable patient risk factors should be addressed prior to surgery. Nutrition should be optimized when feasible. A three-stage approach is recommended for patients with severe colitis and/or those on large dose steroids and immunosuppression. The use of biologic therapy for UC has been shown to increase septic complications after IPAA and in such patients a 3-stage operation is advisable. Body mass index > 30 kg/m^2 is also associated with septic complications after IPAA and obese patients should be counseled appropriately in advance of surgery; an initial abdominal colectomy and/or bariatric surgery to allow control of disease and achieve weight loss should be considered prior to IPAA. Since a missed diagnosis of CD affects pouch outcomes, when biopsy does not clarify the colitis preoperatively, an initial subtotal colectomy may help ascertain the diagnosis of CD and determine the suitability of a pouch at the subsequent operation.

C. Advances in pouch surgery include minimally invasive robotic and laparoscopic IPAA. In addition to the known recovery benefits of minimally invasive surgery, there is evidence for reduced post-operative morbidity in all patients, and in female patients improved fertility using these techniques. There are limitations with these procedures in terms of stapling at the low rectum and allowing for lengthening procedures. The operative time is also increased. Where possible minimally invasive approaches should be used.

D. Complications of IPAA can be categorized into intra-operative, early post-operative and late (see Table 92.1). It is generally accepted that septic complications occurring within 1

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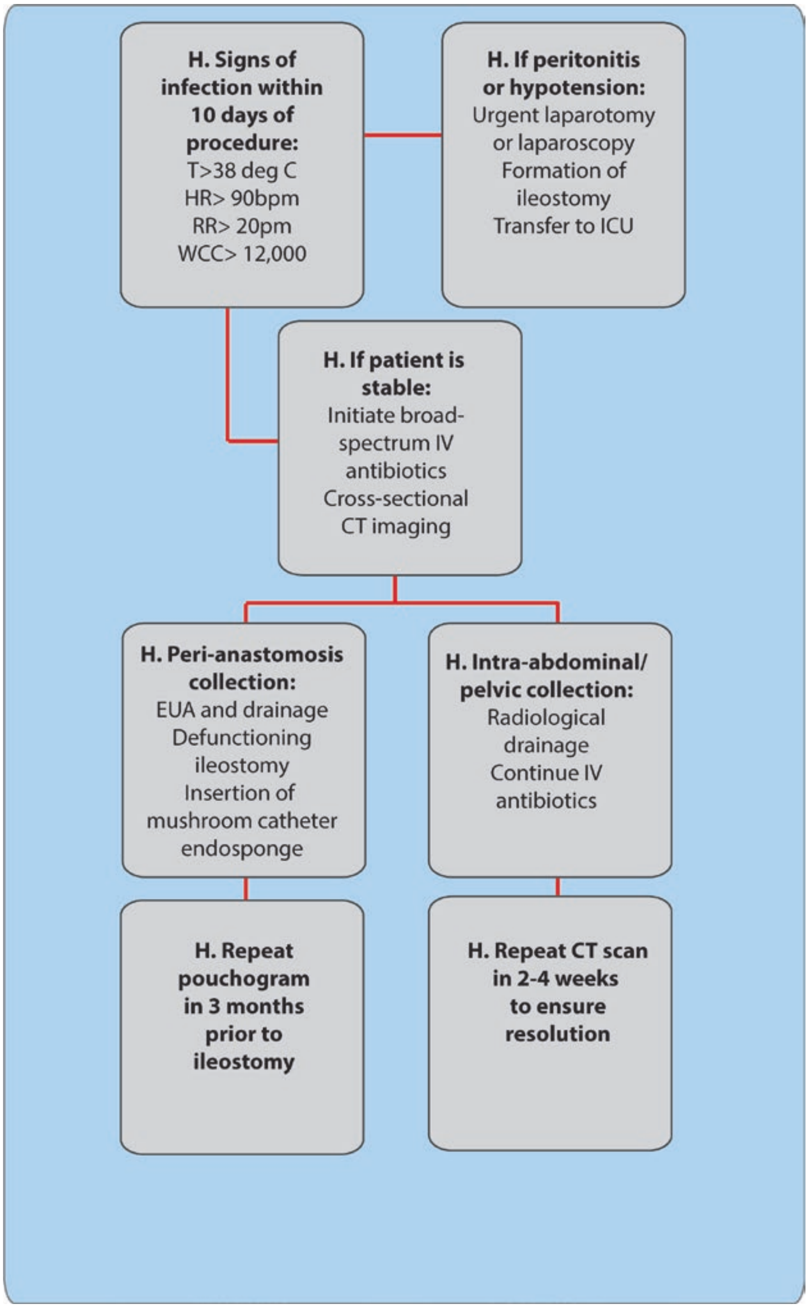


Fig. 92.1 Algorithm for management of early septic complications

year of surgery or stoma closure are related to technical failure, whereas late septic complications and fistulae may indicate a diagnosis CD. Prompt recognition and multidisciplinary management are important to try to ensure pouch retention.

E. Adequate reach of the pouch to the residual anal canal to allow a tension-free anastomosis is critical to IPAA. Ensuring this goal can be a technical challenge. Patients who are tall, with elevated BMI and for those who have had extensive previous abdominal or pelvic surgery are particularly at risk for reach problems. Patients with desmoid tumors or pancreatitis may also have reach problems. Maneuvers to facilitate reach include high ligation of the ileocolic vessels, complete release of the small bowel mesen-

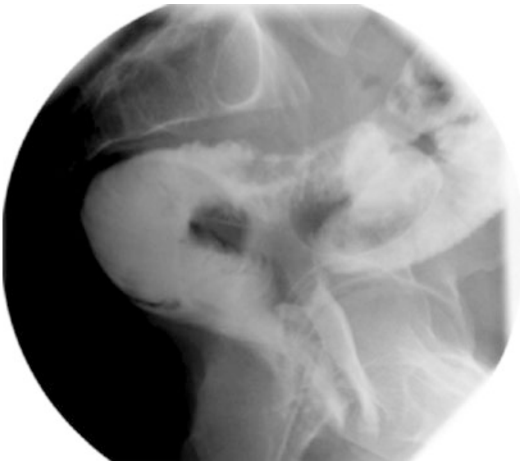


Fig. 92.2 Pouch vaginal fistula

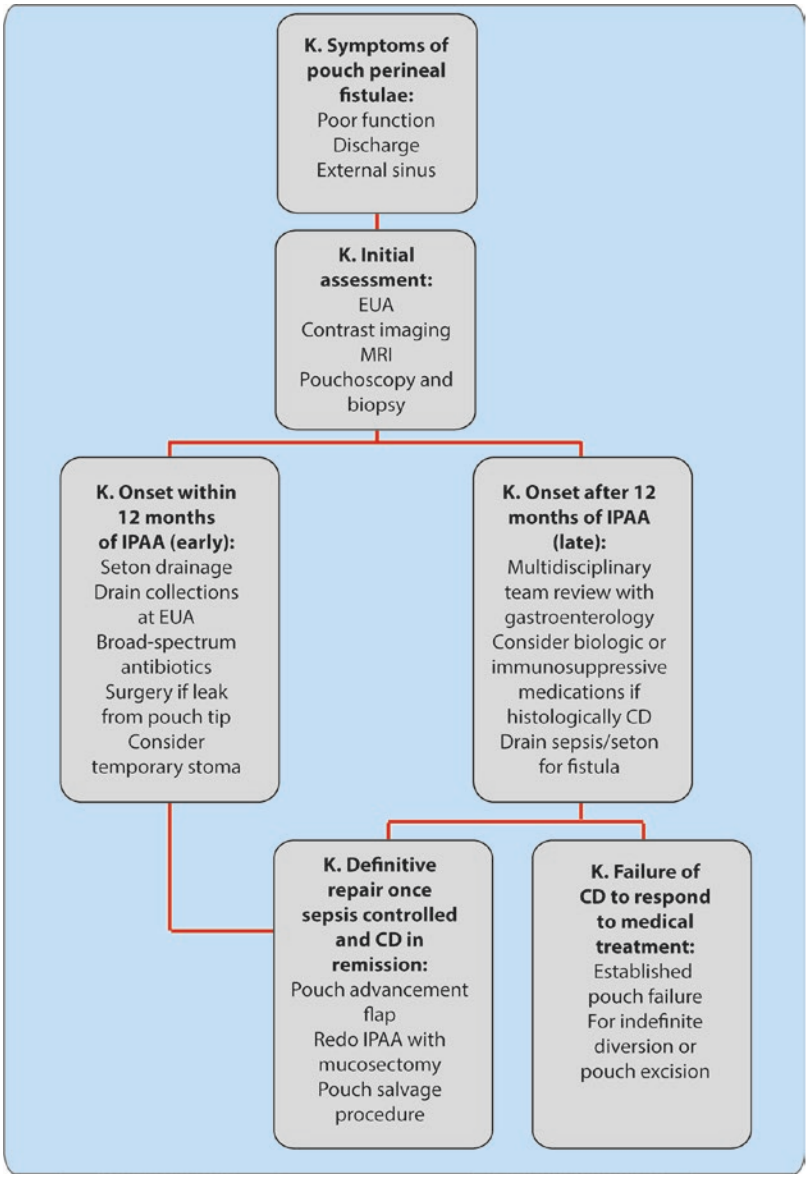
tery, mobilization of the duodenum, and excision of the redundant mesenteric tissue lateral to the superior mesenteric vessels. Releasing 'stepladder' incisions across the mesentery supplying the pouch provide an added length of 1–2 cm. Other techniques that gain length include trans-illumination of the mesentery with division of vascular branches between the primary and secondary arcades that are under tension (may add an additional 2–5 cm), or in rare instances using an interposition vein graft to the SMA to facilitate adequate length. Anterior (rather than posterior) positioning of the pouch mesentery during anastomosis may also allow the pouch to reach the anal canal. Difficulty with reach may be evaluated using a long Babcock to simulate the reach of the proposed apex of the pouch into the pelvis. This exercise is done prior to completing the proctectomy. In certain circumstances, the rectal stump may intentionally be left slightly longer in order to minimize tension at the IPAA. If a "J" pouch cannot reach despite such maneuvers, changing to an "S" configuration may add approximately 2 cm of extra length to the IPAA.

F. Intra-operative pouch ischemia can be caused by direct trauma from scoring the mesentery or by a traction injury across the mesentery due to excessive tension. Twisting the pouch around its mesentery as it is brought down to the IPAA can cause ischemia or necrosis. Confirming correct orientation of the pouch by following the cut edge of the ileal mesentery from the mobilized duodenum to the IPAA prevents twisting. Creating a defunctioning loop ileostomy for an IPAA patient can be challenging in patients with difficult reach or high BMI. One possible option is to defunction using more proximal ileum. Patients thus diverted need to be monitored for high ostomy output.

G. The integrity of the pouch is intra-operatively assessed with an air-leak test which can be undertaken with a rigid or flexible endoscope. Prior to deploying the stapler, it is important to exclude nearby pelvic structures to avoid incorporating them into the stapler mechanism. This precaution requires a combination of careful visual assessment through the abdomen and a digital exam to confirm that the vagina is free. Failure of the stapler to seal the anal/rectal stump may be due to staple misfire or inability of the stapler to approximate thick tissue. Options for management include the placement of a transabdominal or transanal purse-string. The latter maneuver can be facilitated by using eversion sutures that efface the anus and thus provide adequate exposure. The long suture or staple line within the pouch may predispose patients to perioperative bleeding, which usually presents as rectal bleeding. Although severe bleeding is uncommon, the problem may be troublesome. Pouchoscopy with cauterization of any bleeding points, hemostatic clips or injection of epinephrine usually controls bleeding. With diffuse oozing, ice-cold saline with epinephrine placed in the pouch may allow control. Meticulous suture reinforcement of the long stapler lines to ensure hemostasis during IPAA construction is important.

H. Pelvic sepsis can occur in up to 25% of patients after IPAA and is usually due to anastomotic disruption or less commonly due to disruption of the staple line at the tip or body of the pouch; it is the most common cause of pouch failure. Patients with a pelvic abscess can present with abdominal pain,

Fig. 92.3 Algorithm for management of pouch fistulas



fever, leukocytosis and systemic signs of sepsis. The presentation may be indolent and manifest as a prolonged ileus. Imaging with an abdominopelvic CT scan will confirm the presence of abscess and anastomotic leak. Intraabdominal abscesses require drainage, which may be performed percutaneously or surgically and treated with intravenous antibiotics. Pre-sacral and peri-anastomotic collections can be drained at examination under anesthesia, with decompression and drainage of the abscess cavity with a mushroom catheter through an anastomotic defect. The use of endo-sponge topical negative pressure treatment for posterior anastomotic leak with a pre-sacral cavity can promote pouch retention. CT guided drainage can be performed by the trans-abdominal or trans-sacral approach. Drainage through the perineum or vagina should be avoided since these routes can lead to formation of chronic fistula. Abscesses can spontaneously drain

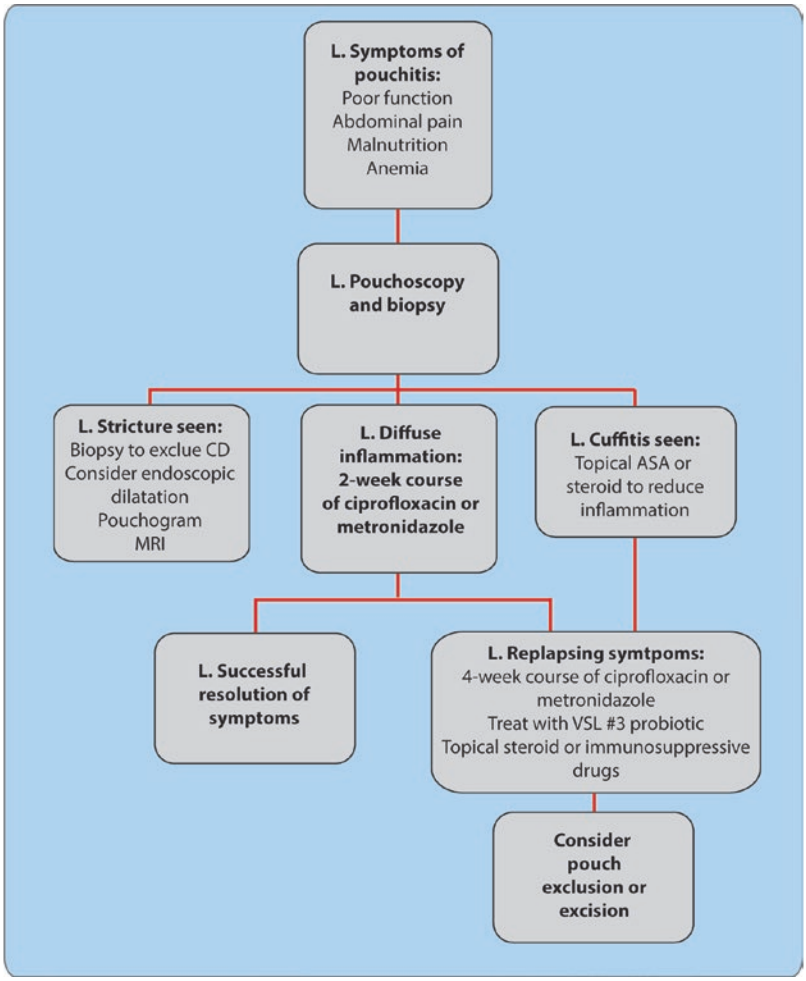


Fig. 92.4 Algorithm for management of pouchitis

Table 92.1 Classification of J pouch complications

Intra-operative	Inability to reach
	Pouch ischemia or torsion
	Technical failure of staplers
Early post-operative	Anastomotic leak and pelvic sepsis
	Pouch hemorrhage
Late post-operative	Pouch-vaginal or perineal fistula
	Pouch sinus
	Reclassification as Crohn's disease
	Poor function
	Pouchitis and cuffitis
	Pouch prolapse
	Dysplasia or cancer of the pouch or of the retained anal transitional zone

into the IPAA through the staple line and may lead to formation of stricture or sinus. A leak from the tip or body of the J pouch can be detected endoscopically or with a pouchogram. Management depends upon the condition of the patient, nature and degree of the defect (refer to Fig. 92.1). Options include endoscopic drainage or salvage surgery with pouch repair of the leak site. Early recognition and prompt treatment of patients with pelvic abscesses is likely to result in preservation of the pouch with functional results similar to those for patients who did not have sepsis (75–90% preservation), whereas delayed treatment leads to formation of a

scarred, non-compliant pouch and is associated with a high likelihood for pouch failure and excision. Hemodynamic instability and peritonitis in patients with pelvic sepsis mandate an exploratory laparotomy with peritoneal washout and the creation of an ostomy if the pouch was not defunctioned. Patients who require laparotomy have a high rate of pouch excision (>40%) and a low rate of ileostomy closure.

I. Pouch-vaginal fistula (PVF) (Fig. 92.2) occurs in 3–16% of IPAA and may arise due to separation of the anastomosis from hematoma, pelvic sepsis, technical failure during surgery or development of CD. PVF can present with discomfort, recurrent vaginal and urinary infections or discharge. Assessment of PVF requires examination under anesthesia with pouchoscopy and vaginal examination. Water-soluble contrast studies via the vagina or pouch and magnetic resonance imaging (MRI) of the pelvis may provide additional information. Management depends on the level of the fistula, the amount of pelvic scar tissue and previous treatment. PVF that presents several years after stapled IPAA are often short and arise on the anterior aspect of the staple line. A short, low fistula with healthy surrounding tissue and no inflammation can be repaired with a trans-anal advancement flap. If there is evidence of active inflammation, induration, or an abscess cavity, drainage and placement of a seton may allow resolution of the infection and normalization of the tissues so that future repair may be feasible. Additionally, medical treatment with antibiotics, or biologics in CD may be required to reduce inflammation before the consideration of a definitive procedure. The chance of success of local perineal procedures may be increased by the use of a loop ileostomy. Redo IPAA, although associated with a relatively high risk for pouch failure may be an option for selected patients. Approximately half of patients with a PVF undergo successful initial closure without recurrence whereas in the rest, PVFs can persist and recur indefinitely even after repeated repairs necessitating pouch excision or permanent stoma formation. A useful alternative is the gracilis interposition. Success can be noted in the majority of patients.

J. Pouch sinus, generally considered an anastomotic leak confined to a blind-ending tract, occurs in 2–8% of patients after IPAA. While these tracts may be asymptomatic and incidentally discovered, some patients present with pain, discharge and poor pouch function. Surgical options including debridement, de-roofing, fibrin glue injection, pouch revision and redo pouch have all been described with variable rates of healing. Symptomatic presentation is a significant predictor for low healing rates and is associated with a high risk of pouch failure. Management is individualized and depends on the presenting symptoms, size, and location of the sinus. Observation, when permitted by clinical circumstances, allows spontaneous resolution of some sinuses. Sinuses detected incidentally in patients without an ostomy are usually best left alone. When a sinus is incidentally detected during routine evaluation before stoma reversal, delaying reversal for a few months until repeat evaluation demonstrates healing of the sinus. Proceeding with ileostomy reversal may be considered in selected asymptomatic patients who have a persistent small tract.

K. The diagnosis of Crohn's disease (CD) is considered in any patient presenting with fistulizing disease after pouch surgery since the diagnosis affects management and prognosis. 5–10% of patients who undergo IPAA for UC will eventually be diagnosed with CD. CD can affect the small intestine proximal to the pouch, the pouch itself, or the perineum and is an independent predictor of pouch failure. The diagnosis of CD after pouch surgery is usually based on the presence of late perianal fistula, non-necrotizing granulomas on histopathology or inflammation and ulceration in the afferent limb or small intestine on endoscopy or MRI. Confirming the diagnosis of CD after pouch surgery can be difficult as the manifestations can overlap with presumed post-oper-

ative complications. Management depends on CD phenotype (inflammatory, fibrostenosing, fistulizing) and symptoms. Treatment relies on a combination of medical therapy for Crohn's disease and tailored surgical intervention. Endoscopic balloon dilation may be used for isolated short-segment strictures. Surgery for strictures involves bowel-preserving strictureplasty where possible. In the presence of localized disease strictureplasty of the pouch body and small bowel proximal to the pouch with or without a defunctioning ileostomy may help control symptoms and salvage the pouch. Perianal fistulizing disease may be managed with seton drainage and medical therapy in anticipation of future surgical intervention with flap repair (refer to Fig. 92.3). A late diagnosis of CD after IPAA does not necessarily condemn the patient to a permanent stoma or excision of the pouch. Multidisciplinary management of CD with appropriate use of biologic therapy may induce and maintain remission and result in acceptable function. Both infliximab and adalimumab are well tolerated and efficacious in treating pouch-related CD. Extensive or refractory Crohn's disease may require diversion and possibly pouch excision.

L. Cuffitis may occur in 2–6% of patients with ulcerative colitis after stapled IPAA, as the technique leaves 1–2 cm of anal transitional zone or rectal cuff, which is susceptible to recurrence of residual UC. A significant correlation has been noted between pouchitis and cuffitis. Although cuffitis may respond to topical steroid enemas, suppositories or aminosalicylate (5-ASA) drugs, it sometimes proves refractory and necessitates surgery. The residual rectal mucosa can be dissected via a sphincter-preserving transanal mucosectomy, provided that the initially stapled anastomosis is within 3–4 cm of the dentate line, and a redo handsewn IPAA performed. Nonspecific inflammation of the ileoanal pouch in the absence of local complications is termed pouchitis. It is the most common long-term complication after IPAA and occurs in 40–70% of patients. The incidence increases with time and the pathogenesis is unknown. Reported risk factors for development of pouchitis include extensive UC, backwash ileitis, extra-intestinal manifestations especially primary sclerosing cholangitis, the presence of perinuclear antineutrophil cytoplasmic antibodies and nonsteroidal anti-inflammatory drug (NSAID) use. There are no universally accepted diagnostic criteria for pouchitis and diagnosis depends on a triad of clinical symptoms, endoscopic appearance and histologic features. Symptoms include increased frequency of loose bowel movements, tenesmus, rectal bleeding, lower abdominal cramping, pelvic pain, and malaise. Features of pouchitis on endoscopy include a friable, ulcerated mucosa that bleeds easily, nodularity, or presence of exudates. Biopsies may reveal increased villous atrophy, acute and/or chronic inflammatory infiltrates, crypt abscesses, and ulceration. The Pouchitis Disease Activity Index (PDAI) is the most commonly used diagnostic scoring system for pouchitis, quantifying clinical signs, endoscopic and histologic features. Diagnosis is often empirically made by clinicians based on clinical grounds, with endoscopy performed if the diagnosis is not clear or if the disease persists. Patients with pouchitis generally respond to oral antibiotics such as Ciprofloxacin (250 mg twice daily), or Metronidazole (500 mg three times daily) for 2–4 weeks. Clinical improvement is usually seen within 3–4 days. Patients with recurrent or persisting disease should be considered for a longer duration of antibiotic treatment, use of amoxicillin/clavulanic acid, oral corticosteroids, allopurinol, 5-ASA or steroid enemas. The use of probiotics has been shown to be beneficial in the primary prevention of pouchitis. In approximately 40% of cases, acute pouchitis will present as a single episode without recurrence. However, in 60% of patients acute pouchitis will follow a relapsing course after the first episode, and 10–30% of patients will develop a chronic, unremitting form or refractory pouchitis. The major-

ity of these patients can be controlled with cyclical long term antibiotic use (refer to Fig. 92.4). A small minority of patients with treatment-resistant pouchitis may require diversion or pouch excision.

M. Dysplasia and cancer can develop in the pouch, retained rectal mucosa or in the anal transition zone after IPAA in patients with FAP or UC. Cancer is a rare phenomenon with under 50 cases reported. Mucosectomy at the time of IPAA does not prevent future dysplasia as islands of rectal mucosa may persist at the time of IPAA. The development of dysplasia or cancer within the pouch in UC is extremely rare such that routine surveillance of the pouch is not warranted unless patients have pre-existing colonic dysplasia. FAP patients with either stapled or hand-sewn IPAA after mucosectomy, should be counseled about the future risk of malignant transformation or polyposis in or near the anal transition zone and should undergo annual surveillance. Previous colorectal dysplasia or cancer and chronic pouchitis are risk factors for pouch neoplasia; these patients may benefit from a more targeted pouch surveillance. Patients with UC or FAP with focal dysplasia are recommended to undergo ablation or excision and surveillance if the dysplasia is persistent. Patients with invasive cancer will require radical surgery with pouch excision to achieve cure.

N. Pouch prolapse is a rare complication that occurs in 0.3% of pouch patients. Patients may present with tissue prolapse or outlet dysfunction. Defecating pouchogram and examination under anesthesia may provide the diagnosis. Stool bulking agents and biofeedback to modulate evacuatory technique may be helpful in mucosal prolapse. When symptoms persist, a local perineal procedure with pouch advancement after the excision of redundant pouch can be considered. Care must be taken to divide the mesentery on the bowel wall to present devascularization of the efferent limb. Patients with full-thickness pouch prolapse are best treated with definitive transabdominal surgery. Ventral pouchpexy with fixation of the pouch to the sacrum using non-absorbable sutures and acellular dermal matrix mesh is usually undertaken. Irritable pouch syndrome (IPS) is a rare functional disorder characterized by increased stool frequency, urgency, and abdominal pain in patients who do not meet the diagnostic criteria for either pouchitis or cuffitis and is a diagnosis of exclusion. Treatment of IPS is empiric and consists of dietary modification low-fat, low-carbohydrate diet, avoidance of dairy products), antispasmodic agents such as Hyoscine and Buscopan, antidiarrheal agents including diphenoxylate, Loperamide and Cholestyramine, or tricyclic antidepressants such as Amitriptyline.

O. Indications for abdomino-pelvic IPAA revision include an excessively long efferent limb, a small pouch, a mobile afferent limb causing outflow obstruction, a long stenosis caused by partial separation or retraction of the pouch, a twisted pouch, or intussusception. Septic or inflammatory causes include partial separation, sinus formation, significant residual rectum with cuffitis or stenosis. Prior to IPAA revision, a careful evaluation with accurate history taking and physical examination of the IPAA, imaging (CT, MRI, small bowel contrast study especially if CD is suspected), manometry of the anal sphincter and pouch, and endoscopy with multiple biopsies are required. Patients need to be fully counselled about the risks, alternatives, benefits and goals of the procedure, as well as the possibility that the pouch may not be salvaged with a permanent ileostomy as the end result. Intraoperative ureteral stents are a useful precautionary adjunct. Adhesiolysis is performed and the ileal pouch identified and dissected with a combination of electrocautery and sharp dissection. The pouch can be disconnected from the anastomosis either by transabdominal or by transanal dissection. Transanal mucosectomy should be performed if residual rectal mucosa is present, taking care to identify and preserve the anal sphincters. The pouch is then revised depending on

the nature of the original problem. The new or modified pouch is then anastomosed to the anal canal. A hand-sewn anastomosis is usually necessary in revision surgery and a diverting ileostomy is almost always performed. A continent ileostomy (Kock pouch) remains a reasonable alternative for patients with a failed IPAA. The ileoanal pouch, if otherwise healthy, can be used to form the reservoir portion of the continent ileostomy ('J' to 'K' conversion). While patients are usually satisfied with their choice of continent ileostomy there is significant associated morbidity, with a 30-day complication rate of 31%, a long-term pouch dysfunction rate of 50% and a pouch revision rates in excess of 50%.

P. In some instances the ileoanal pouch may be indefinitely defunctioned with an ileostomy. This strategy avoids the complications of reoperation in the pelvis and immediately restores health and quality of life and allows the subsequent option of definitive surgery. Periodic surveillance with pouchoscopy is needed in patients diverted for over 1 year, to ensure the early detection of silent neoplastic transformation. In patients where the pouch is not salvageable due to CD, septic complications or cancer, definitive surgery involves pouch excision with permanent ileostomy. Pouch excision does carry the risks of pelvic surgery but over the long term offers better quality of life in comparison to indefinite diversion. If possible, an intersphincteric approach should be employed. In patients with fistulizing CD or cancer, excision will involve a wide perineal extra-sphincteric approach and porcine mesh reconstruction of the wound or gluteal flaps may be needed for assisted perineal wound closure. Delayed perineal wound healing occurs in up to 50% of patients undergoing pouch excision.

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93 Complications: Pouchitis

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Refer to Algorithms in Figs. 93.1 and 93.2

A. Pouchitis is the most common long-term complication in patients undergoing restorative proctocolectomy with ileal pouch-anal anastomosis (IPAA) for medically refractory ulcerative colitis (UC) or colitis-associated neoplasia (CAN). Patients with familial adenomatous polyposis (FAP) who had the same surgical procedure may occasionally experience symptoms of pouchitis. The predominance of UC-associated pouchitis, as opposed to FAP- associated pouchitis suggests the role of systemic, genetic, and microbiological factors in the development of pouchitis.

B. Etiology and pathogenesis of pouchitis is not entirely clear. Since the majority of patients with initial acute episodes of pouchitis respond to antibiotic therapy, microbiota are believed to play a key role in the etiopathogenesis of pouchitis. The contribution of microbiota to the development of pouchitis are two folds: (1) dysbiosis or alteration in quantity or composition of commensal bacteria; and (2) pathogens, including pathogenic bacteria (e.g. *C. difficile*, *C. perfringens*, *Campylobacter* spp., Group D streptococci (*Enterococcus* spp.), hemolytic strains of *E. coli*) viruses (e.g. cytomegalovirus [CMV]), and fungi (e.g. *Candida albicans* and *Histoplasma*). However, in our clinical practice, we have seen a growing number of patients with pouchitis develop a refractory course to anti-microbial therapy. A number of patients may develop chronic antibiotic-refractory pouchitis (CARP).

C. Risk factors for pouchitis, especially CARP, have been extensively studied. The presence of extraintestinal manifestations of inflammatory bowel disease (IBD), particularly primary sclerosing cholangitis (PSC), arthralgia, and arthropathy, has been found to be related to pouchitis. In addition, genetic polymorphisms such as those of IL-1 receptor antagonist, NOD2/CARD15 or a combined carriership of TLR9-1237C and CD14-260T alleles may be associated with pouchitis. The modifiable risk factors include the use of non-steroidal anti-inflammatory drugs (NSAID) and surgery associated ischemia. It is interesting to find that smoking has an opposite effect on acute (exacerbating factor) pouchitis and chronic (protective effect) pouchitis. This suggests that etiopathogenetic pathways of acute and chronic pouchitis are different. Recent data showed that weight

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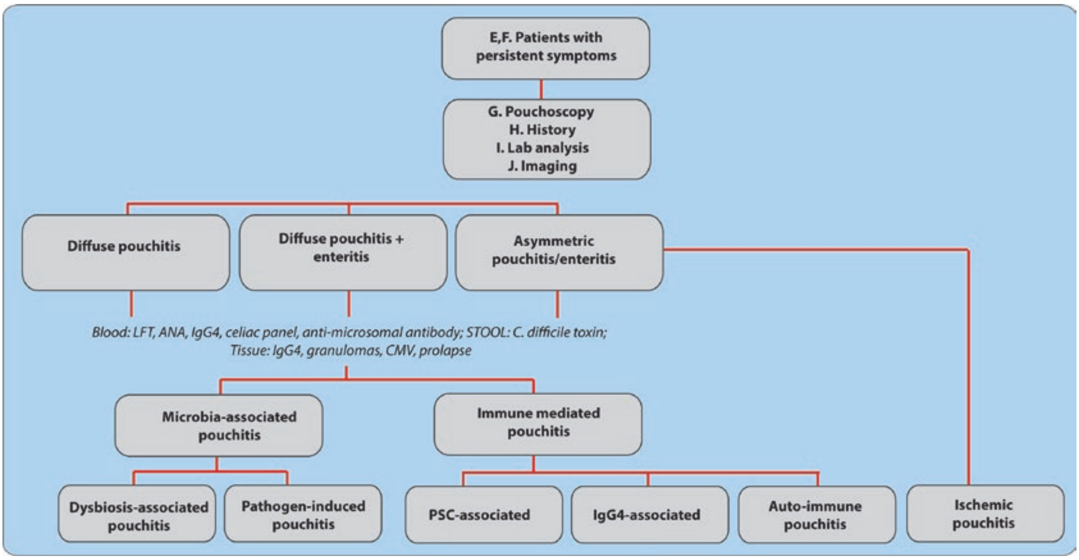

Fig. 93.1 Diagnostic algorithm for pouchitis

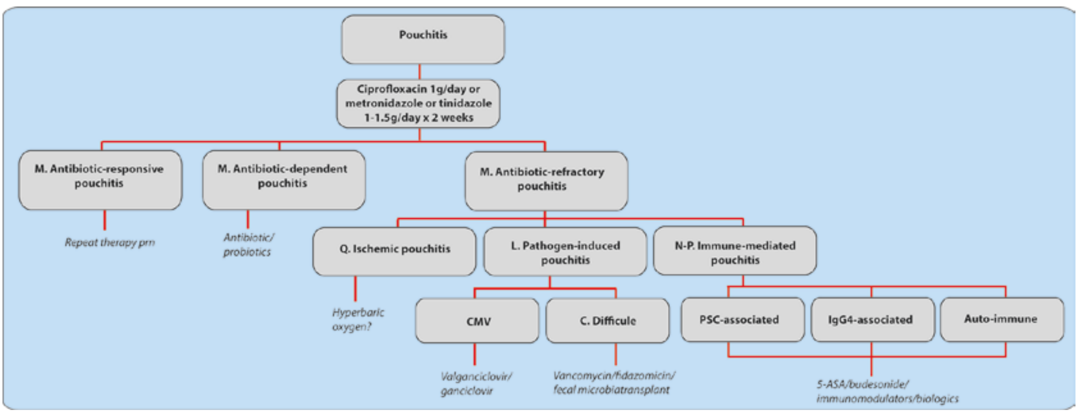

Fig. 93.2 Treatment algorithm for pouchitis

gain, especially gain of mesenteric fat, is related to the development of pouchitis, suggesting the role of mesenteric fat and surgery-procedure associated ischemia. Furthermore, recent studies also reported that *C. difficile*-associated pouchitis, CARP, and presacral anastomotic leak or sinus are predominantly seen in male. With the male gender is the common denominator for the three pouch disease conditions, along with the "reach issue" of pouch body to the cuff mainly seen in male, we speculate that mesenteric fat deposition and pouch ischemia are the contributing factors for pouchitis. It is believed that the risk of pouchitis, especially CARP, can be reduced by the use of proper surgical techniques, life style modification (such as weight loss), and avoidance of NSAID use.

D. Pouchitis is not single disease entity. Rather, it represents a spectrum of diseases with ranging risk factors, clinical presentation, disease course, and prognosis. Proper diagnosis and classification of various phenotypes of pouchitis are important for the management and improvement in prognosis.

Pouchitis can be classified into acute (<4 weeks) and chronic (≥4 weeks) forms, according to the duration of symptoms; antibiotic-responsive; antibiotic-dependent; and antibiotic-refractory phenotypes, based on the response to and frequency of requirement of antibiotic therapy; idiopathic and secondary (such as NSAID-induced, ischemia-related, and CMV-associated) entities, based on the etiology. The terminology combing the above features may be used to characterize certain type of pouchitis, such as CARP or acute NSAID-induced pouchitis. Of note, the phenotype of pouchitis can change over time, in a more unidirectional way. For example, acute antibiotic-responsive pouchitis may evolve into CARP, but not other way around. Pouchitis may be classified three main categories: (1) microbiota-associated; (2) autoimmune-associated; and (3) ischemia-associated, based on the distribution of mucosal inflammation.

E. Patients with pouchitis often presents with increased bowel frequency, loose or watery bowel movement, urgency, nocturnal seepage, abdominal pain or cramps, and pelvic pressure. Those symptoms are not specific for pouchitis, as they can be presented in those with irritable pouch syndrome, small bowel bacterial overgrowth, cuffitis and CD of the pouch.

F. Fever, chills, leukocytosis, not common in classic pouchitis, may be presenting symptoms of pathogen-associated pouchitis or CD of the pouch with abscess. Hematochezia, typically seen patients with cuffitis, is an uncommon presentation for pouchitis. Low back pain or pain at the tip of the coccyx may suggest a diagnosis of presacral anastomotic leak, abscess, or sinus. Weight loss is not common in classic pouchitis. Significant weight loss may trigger a full evaluation of mechanical complications of the pouch, such as anastomotic leak and afferent limb or efferent limb syndrome, CD of the pouch, and concurrent celiac disease.

G. Pouch endoscopy or pouchoscopy is the most valuable diagnostic modality for the diagnosis and differential diagnosis of pouchitis. Pouchoscopy is used to assess the degree and distribution of mucosal inflammation, evaluate structural abnormalities (such as strictures, fistula, and anastomotic leak, bowel angulation, and prolapse), take tissue specimens, and monitor the risk of dysplasia. The distribution pattern of inflammation may provide important clues for diagnosis of various phenotypes of pouchitis, cuffitis, and CD of the pouch. For example, the inflammation of microbiota-associated pouchitis is often limited to the pouch body; the inflammation of autoimmune-associated pouchitis (classic example: PSC-associated pouchitis/enteritis) is extended from pouch body to a long segment of the afferent limb. Mucosal inflammation in ischemic pouchitis is typically asymmetric, involving the distal pouch body, suture line, pouch inlet or afferent limb site of a J pouch body. CD of the pouch often presents with discrete ulcers in the pouch body and afferent limb, often along with strictures and/or fistula.

Symptomatic patients without endoscopic inflammation in any segments of IPAA may be classified as having irritable pouch syndrome or small intestinal bacterial overgrowth. Those patients may respond favorable to antibiotic therapy.

Esophagogastroduodenoscopy (EGD) may be performed in patients with autoimmune-associated pouchitis or CD of the pouch, and those with suspected celiac disease.

H. The role of mucosal biopsy for the evaluation of pouch disease is to identify neoplasia, ischemia, prolapse, granulomas, virus- or fungus-infected mucosa. The accuracy of mucosal biopsy in grading severity of mucosal inflammation is limited. Immunohistochemistry can be performed to evaluate CMV infection.

I. Laboratory tests should be routinely checked. Commonly ordered tests include complete blood counts, comprehensive metabolic panel, and C-reactive protein. Fecal lactoferrin or calprotectin may be used as surrogate markers for mucosal inflammation. We routinely check *C. difficile* test. In patients

suspected of autoimmune-associated pouchitis, we routinely check serum anti-nuclear antigen, IgG4, microsomal antibodies. For patients suspected pathogen-associated pouchitis, serum CMV DNA and fungal battery may be assayed.

J. Abdominal and pelvic imaging is mainly used for the differential diagnosis of pouchitis. Ischemic pouchitis may occasionally demonstrate non-hyperenhancement of mucosa in contrasted CT or MRI. CT and MRI have been routinely used to assess the presence of stricture, fistula, abscess, or anastomotic leaks. Gastrograffin enema and barium defecography have been very useful to evaluate stricture, anastomotic leak or sinus, prolapse, angulation of bowel lumen.

K. It is important to follow the disease course of pouchitis. If a patient develop "pouchitis" immediately after ileostomy closure, concurrent mechanical diseases, such as stricture and anastomotic leaks, should be evaluated. If a patient has a normal pouch for many years and gradually develops pouchitis, particularly CARP, triggering factors such as weight gain and abdominal surgery with mesh placement, should be investigated.

L. Treatment of pouchitis is largely based on the underlying risk factors and disease phenotype. For pathogen-associated pouchitis, we are able to choose proper agents for the targeted therapy. For example, *C. difficile*-associated pouchitis may be treated oral vancomycin or fidaxomicin. For patients with recurrent or refractory *C. difficile* pouchitis, fecal microbiota transplant (FMT) may be attempted. For patients with dysbiosis-associated pouchitis, broad spectrum oral antibiotics, such as ciprofloxacin, metronidazole, and tinidazole, may be used.

M. For patients with antibiotic-dependent pouchitis, probiotic agents, such as *Lactobacillus GG* and VSL#3, or a low dose of antibiotics, such as luminal active rifaximin, may be tried.

N. Treatment of CARP can be challenging. It is important to modify exacerbating factors, such as NSAID use. Prolonged courses of dual oral antibiotics, topical mesalamines, and topical corticosteroids may be tried. For patients with autoimmune associated pouchitis, often in the form of CARP, oral budesonide (9 mg/day for treatment and 3–6 mg/day for maintenance can be helpful.

O. The role of immunomodulators, such as azathioprine, 6-mercaptopurine, and methotrexate in the treatment of pouchitis is not well defined. This author has found that low dose of 6-mercaptopurine (i.e. 50 mg/day PO) or methotrexate (12.5 mg QW SQ) has been effective in some patients with autoimmune-associated pouchitis.

P. While anti-tumor necrosis factor (TNF) agents have been effective in treating CD of the pouch, their use in treating CARP warrants further investigation. In the published case series in the literature, infliximab and adalimumab are effective in some patients with CARP, particularly in those with concurrent fistula. The results raise a question on whether those patients had CD of the pouch, rather than CARP. Vedolizumab, a gut-selective anti-integrin monoclonal antibody, has been shown promising results in the treatment of CARP.

Q. Currently, there are no established medical treatment for ischemia-associated pouchitis. This author found that hyperbaric oxygen therapy may be beneficial.

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94 Complications: Reoperative Pelvic Surgery

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Refer to Algorithm in Fig. 94.1

A. Population based data suggest that the risk of anastomotic leak after low anterior resection is actually 10–15%, which is substantially higher than the approximately 5% risk often cited in single institution case series (Fig. 94.2). Many pelvic anastomoses that are complicated by a leak heal spontaneously or with local measures, enabling successful stoma closure. However, a significant proportion of patients will develop refractory complications such as a presacral sinus/fistula, smoldering infection, and/or a rigid, unyielding anastomotic stricture. Chronic low grade pelvic sepsis following an anastomotic leak may result in a restrictive fibrotic rind around the rectal reservoir yielding an unacceptably poor functional outcome. These scenarios will generally require operative correction if gastrointestinal continuity is to be durably restored.

B. Patients requiring reoperative pelvic surgery for anastomotic complications have typically been treated with an initial strategy to manage the acute consequences of the leak/stricture. Proximal diversion at the time of the index procedure usually protects the patient from the risk of florid pelvic sepsis and the associated need for acute reoperation. Those patients undergoing colorectal or coloanal anastomoses without prophylactic diversion more often require operative intervention and secondary stoma creation to manage the leak. Many such patients also undergo trans-anastomotic and/or percutaneous drainage procedures to control local sepsis. Virtually all instances of complicated anastomotic healing result in prolonged hospitalization, and the need for additional invasive interventions and/or extended antibiotic treatment to control local sepsis, often resulting in staggering resource utilization and costs.

C. Legendary UCLA basketball coach John Wooden said, “Failing to prepare is preparing to fail.” No principle could be more fundamental when planning reoperative pelvic surgery. A sober preoperative assessment of the patient’s expectations/goals of treatment, patient comorbidities and the particulars of the local situation is crucial to safe and sound medical decision making. This includes obtaining and reviewing previous operative and pathology reports as well as imaging studies to become familiar with the details of the patient’s anatomy and previous

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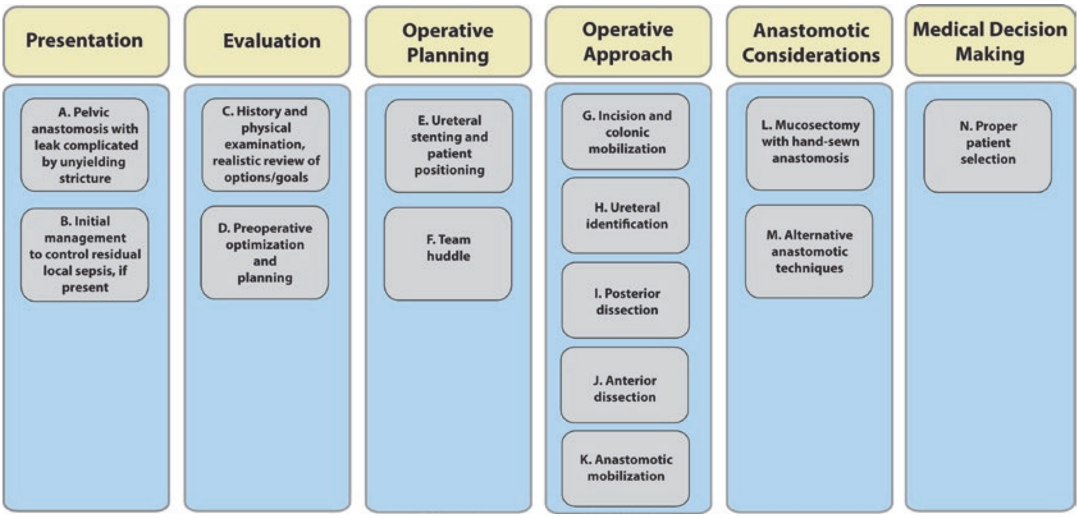

Fig. 94.1 Algorithm

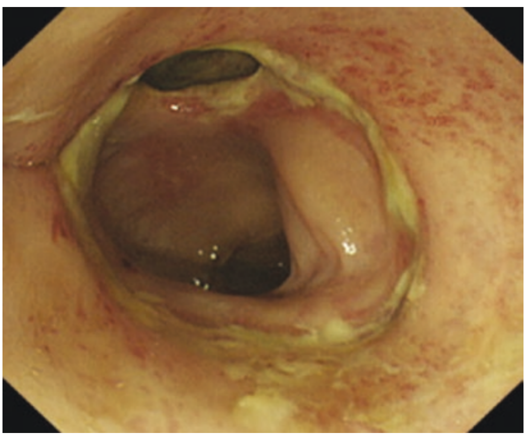

Fig. 94.2 Anastomotic disruption after low anterior resection: Note defect at 12 o'clock position

interventions. A thoughtful history and physical examination, including digital rectal exam, as well as careful assessment of patient's baseline continence status are typically quite revealing. A concurrent visit with an enterostomal therapist (even if the patient already has a stoma) is often invaluable. Based on the operative plan, selecting potential sites for a new stoma is commonly required; even if there is a preexisting stoma, this consultation can be of great value in making the right choices. How important is ending up without a permanent stoma for the patient? Is their intense desire to get rid of their ostomy related to poor siting, a poorly constructed stoma, a suboptimal pouching system or inadequate education? Optimizing the present ostomy care plan and/or operative revision to a high quality permanent stoma is commonly the safest and often the most appropriate option.

D. Can anything be done to optimize the patient's clinical status prior to surgery? Have all collections been drained and is there optimal control of local sepsis? Has the patient stopped smoking? Is the patient nutritionally optimized? Is there any "preconditioning" (e.g. exercise regimen) that might enhance their physiologic reserve and limit the risk of complications? Is further evaluation of the anastomotic site with flexible endoscopy, imaging studies and/or examination under anesthesia to provide a road map and/or exclude cancer recurrence needed? Is this person who may have initially expected a short hospitalization and rapid return to their usual health status/lifestyle after their index

operation, but instead spent weeks or months in the hospital replete with multiple invasive procedures, really physically, psychologically and physiologically ready for another major operation? The options for re-doing the anastomosis may include stapled low or ultra-low colorectal anastomosis, but mucosectomy with handsewn or delayed coloanal anastomosis are frequently necessary; is the surgeon comfortable offering all of these options and would the help of an experienced colleague be of value? It is our usual custom to allow at least 6 months for the patient to fully recover and for the local conditions to become more favorable before embarking on reoperative pelvic surgery.

E. It is important to acknowledge and appreciate that pelvic anatomy will be altered, landmarks less reliable and dissection planes difficult to identify; these are not cases we have considered approaching laparoscopically. We use bilateral ureteral stents in almost all cases of reoperative pelvic surgery. Although ureteral stents do not necessarily prevent ureteral injury, they facilitate prompt identification of the ureters in what is often a densely scarred pelvis and enable early recognition of ureter injury. The patient is carefully positioned in modified (low) lithotomy to avoid excessive external rotation or flexion of the hips; this is combined with proper padding in preparation for a potentially long case as well as enabling access both to the anus and vagina. A Foley catheter is placed, prophylactic antibiotics are administered and redosed as appropriate and subcutaneous heparin is routine. Warming devices and attention to room temperature that minimizes the risk of hypothermia and associated coagulopathy, yet allows surgeon comfort, are important.

F. Prior to starting, a "huddle" with the team can be of great value in making sure all instruments are available and to review a step-by-step algorithm for how the case will proceed. Clear communication with the anesthesia team helps get them engaged, and ensures everyone is on the same page with regard to the potential length of the operation, plan for judicious fluid management, as well as the potential need for changes in patient position. Again, preparation is key and a "we will see what happens when we get there" approach leads to inefficiency and ineffectiveness; furthermore, it risks injury to adjacent organs from unnecessarily dissection in places where the surgeon does not need to be.

G. A generous midline incision is made and the splenic flexure thoroughly mobilized, usually including secondary division of the inferior mesenteric vein at the inferior border of the pancreas to ensure a subsequent tension free future anastomosis. Performing this step early on in the operation saves time, making it unnecessary to change the exposure during later steps of the operation. All small bowel loops are liberated from the pelvis and packed away so that only the pelvic organs remain.

H. We start often by identifying the left ureter proximally and dissecting the left colon off the retroperitoneum down into the pelvis. The key is to establish as many "normal" planes as possible before attacking the scarred, densely adherent and fibrotic areas of the pelvis where the planes need to be "imagined". Once the distal colon and its mesentery have been freed from the retroperitoneum on the left, a finger can be insinuated under the mesentery to locate the correct plane on the right as necessary. The right ureter is then identified and the peritoneum on the right side of the pelvis opened.

I. Once the planes lateral to the mesocolon and mesorectum have been established, we sharply dissect posterior to the mesentery as far down as we can. We tend to stay away from the anterior portion of the dissection until the planes on the left, right and posteriorly have been established. It is important to understand that reoperative pelvic surgery is fundamentally different than the index operation. The previous anastomosis is typically

fixed deep in the pelvis and will not deliver with upward traction; in fact, upward traction will often lead to anastomotic avulsion or disruption. What was initially 5–6 cm from the anal verge at the index procedure, is functionally much lower in a redo case. The anastomosis is commonly fixed to the distal sacrum and coccyx and often needs be sharply dissected with a scissor or even a scalpel blade.

J. During reoperative pelvic surgery, anterior dissection is commonly a challenging task. Quite often, the colon is densely adherent to the distal bladder and/or vagina. Sharp dissection flush with the rectal wall is prudent. This can be facilitated with the help of a perineal assistant who can place a rigid proctoscope or a finger in the rectum and vagina. This maneuver can be an invaluable aid to interpreting the anatomy, as relationships are often distorted and visual clues limited or absent. With higher anastomoses above the peritoneal reflection, it is often possible to complete the posterior and lateral dissection and then open the anterior peritoneal reflection to identify the rectal wall below the previous anastomosis. Now with clear identification of the anatomy above and below the old anastomosis, the intervening tissue in the anterior plane may be readily and confidently divided.

K. As noted previously, the actual location of the anastomosis is usually deeper in the pelvis than one might expect based on measured distance at endoscopy, due to scarring and tissue fixation. If it is possible to mobilize and safely dissect below the anastomosis, then a standard double stapled technique may be used; division of the rectum using a linear stapler (or purse string closure) followed by an end-to-end anastomosis with a circular stapling device is performed. However, it is important to recognize when safe separation of the distal rectum from the surrounding structures, such as the vagina, cannot be achieved to obtain a secure rectal stump closure. This is predictable for previous anastomoses to the distal rectum and in many cases to the midrectum. In this situation, endoanal technique with a pullthrough procedure will be required; the sooner this is recognized, the better. To improve functional outcomes, creation of a colonic reservoir with a colonic J-pouch, coloplasty in a Heineke-Mikulicz fashion, or side to end anastomosis may be chosen.

L. In cases requiring a pullthrough, a mucosectomy is performed starting just above the dentate line to create a rectal muscular tube so that the colon or colonic reservoir can be pulled through and anastomosed to the anal canal at the dentate line. Great care must be taken to assure the anastomosis is not twisted during the "transfer" from the pelvic to the perineal operator; we prefer to place four corner sutures in the colon with tags labelling the anterior, posterior, right and left sided sutures. We have found that using the circular stapler in difficult circumstances such as the obese male with a narrow pelvis, to staple the colon to the area of the dentate line is very effective in bringing the proximal colon down while maintaining and "holding" the colon in an appropriate orientation to complete the anastomosis. Although this circular staple line is typically incomplete with only perhaps 50–80% of the anastomosis intact, it facilitates completion of the anastomosis with sutures.

M. In thinner patients, a coloanal anastomosis can usually be readily achieved in the lithotomy position. However, in larger patients, we prefer to complete the anastomosis in the prone jackknife position (Fig. 94.3). In cases where a concomitant repair of a rectovaginal or rectourethral fistula is performed, one may choose to perform a Turnbull-Cutait delayed coloanal anastomosis. Following a rectal mucosectomy, the colon is pulled through the rectum, with 7–10 cm externalized and wrapped in petrolatum or betadine soaked gauze for up to 7 days. Upon return to the operating room, the externalized segment is resected and a delayed hand-sewn coloanal anastomosis created. We routinely divert all coloanal anastomoses.

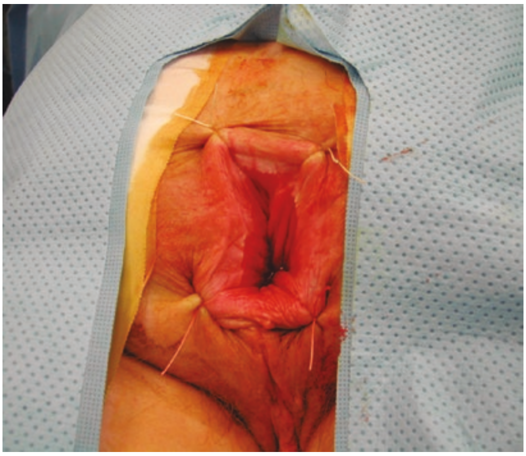

Fig. 94.3 The patient is placed in the prone jack-knife position to prepare for mucosectomy. Everting sutures are used to facilitate exposure

N. It is important to highlight the importance of sensible deliberation in deciding what one should do for the patient, rather than what one can technically do. The functional limitations of a coloanal anastomosis are considerable, especially in the reoperative setting. Even in the setting of an uncomplicated recovery, bowel-related quality of life is often markedly impaired with a substantial number patients experiencing a major detriment to their quality of life. Many patients, such as those with advanced age, frailty, persistent pelvic sepsis, and baseline incontinence, would likely benefit more from a well-constructed end descending colostomy than reestablishment of bowel continuity.

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Index

A
Abdominal approach
  rectal prolapse/recurrence, 223
  retrorectal, 288
Abdominal cavity, 221
Abdominal wall contouring, 615–617
Abdominal wall reconstruction, 579
Abdomino-pelvic IPAA revision, 726
Abdominoperineal resection (APR), 210, 301, 332, 346
ACOSOG Z6041 trial, 290
Active surveillance, 203
Acute colonic pseudo-obstruction (ACPO), 381
  algorithm, 382
  definitive decompression, 384, 385
  electrolytes, 383
  endoscopic decompression, 384
  etiology of, 381
  evaluation and diagnosis, 381
  medications, 383
  neostigmine, 383, 384
  non-operative measures, 383
  optimization/non-operative management, 383
  plain radiographs, 382
  risk factors, 382
Acute colonic volvulus, 365
Acute diverticulitis, 365
Acute embolism, 548
Acute enteritis, 564, 565
Acute inflammatory process, 558
Acute intestinal injury, 557
Acute Physiology and Chronic Health Evaluation II (APACHE II), 42
Acute thrombosis, 145–148, 548
Adenocarcinoma, 521
Adenomatous polyposis coli (APC), 539, 585
Adenomatous polyps, 451, 452
  chromosomal sequences, 483
  cold biopsy forceps, 485
  colonoscopy and polypectomy, 483
  colonoscopy screening algorithm, 483, 484
  EMR, 485
  endoscopic *vs*. surgical resection, 486
  ESD, 485
  Haggitt classification system, 486
  National Polyp Study, 483
  oncologic principles, 486
  polypectomy, 485
  somatic mutations, 483
  submucosal injection, 485
  TAMIS, 485
  TEMS, 485
Adhesiolysis, 726
Adipose-derived stem cells (ASCs), 130
Adjuvant chemotherapy, 309
Adjuvant therapy, 593
Advancement flap, 84
Aeromonas, 189
Alosetron, 390
Alpha-lipoic acid (ALA), 563
American College of Surgeons National Quality Improvement Program (ACS-NSQIP), 32, 42
American Joint Committee on Cancer staging system, 598
American Society of Anesthesiologists (ASA) score, 40, 41
American Society of Colon and Rectal Surgeons (ASCRS), 472, 489, 511
Amifostine (Ethyol), 561–562
Amitiza®, 390
Amsterdam criteria, 469, 472
Anal cancers, 204, 205
Anal condylomata, 162, 163
Anal fissure, 59
  algorithm, 137–139
  appearance, 137
  arteriography, 83
  atypical fissure, 81
  botox injection, 138
  chronic anal fissure, 82
  clinical history, 81
  definition, 82
  endoscopic evaluation, 81
  fissurectomy, 139
  laboratory evaluation, 81
  laser Doppler flowmetry, 83
  lateral internal sphincterotomy, 138
  pathognomonic presentation, 81
  sphincter hypertonicity, 83

S. R. Steele et al. (eds.), *Clinical Decision Making in Colorectal Surgery*,
https://doi.org/10.1007/978-3-319-65942-8

Anal fissure (*cont.*)
surgical complications, 139
topical treatments, 138
treatment
Botox® injections, 84
comparison trials, 83, 84
cutaneous advancement flap, 84
dietary modifications, 83
LIS, 84
schema, 83
surgery, 84
topical options, 84
typical fissure, 81
Anal intraepithelial neoplasia (AIN)
algorithm for treatment, 202
active surveillance, 203
AIN I, 203, 204
AIN II and III, 204
anal cancers, 204, 205
anal Papanicolaou smear, 201, 202
carcinoma of the anus, 201
condylomata, 203
high-resolution anoscopy, 202
Anal intraepithelial neoplasia I (AIN I), 203, 204
Anal manometry, 266
Anal margin tumors
basal cell carcinoma, 211
Bowen's disease, 210
definition, 207
diagnosis, 209
incidence, 207
large squamous cell carcinoma of, 209
malignant melanoma, 211
Paget's disease, 210, 211
presentation, 208
squamous cell carcinoma, 209, 210
types of, 207
verrucous carcinomas, 211
Anal mass, 59
anal canal and anal margin malignancies, 77
anoscopy, 73
bi-digital rectal examination, 73
biopsy, 77
clinical history, 71
differential diagnosis, 71
digital rectal examination, 71
fistula tract removal, 76
fistula-in-ano, 76
full thickness rectal prolapse, 75
human papilloma virus, 76
hypertrophied anal papillae, 75
internal hemorrhoids treatment, 75
lesions destruction, 76
perianal abscess
clinical manifestations, 73
incision and drainage, 73, 74
physical examination, 73, 74
treatment, 74
prolapsed internal hemorrhoids, 75
STDs, 74
ulcerative lesions, common organisms and viral infections, 74
Anal Papanicolaou (Pap) smear, 201
Anal plug, 268
Anal stenosis/stricture
acquired anatomic anal stenosis, 87
algorithm, 135–137
anal dilatation, 135
balloon dilation, 135, 136
chronic transmural inflammation, 89
classification, 89
complications after flap procedures, 94
congenital anatomic anal stenosis, 87
definition, 87
diamond flap, 92, 93
etiology, 87
fecal continence, 135
flap types, 90, 91
follow-up procedure, 94
functional *vs*. anatomic stenoses, 89
Hegar dilators, 90
hemorrhoidectomy, 87
house flap, 92, 93
infection control, 137
lateral internal sphincterotomy, 94
management algorithm, 88, 89
Martin's anoplasty, 92
physical examination, 135
plastic dilators, 90
preoperative procedure, 91
rectal mucosal advancement flap, 91
rotational S flap, 92, 93
symptoms, 135
transanal rectal stricturoplasty, 137
U-shaped flap, 92, 93
V-Y advancement flap, 92, 93
Y-V advancement flap, 91, 92
Anal tattooing, 166
Anal verge, 207
Anal wink, 5
Analgesia, 49
Anastomotic bleeding, 672, 673
Anastomotic recurrences, 332
Anatomic stenoses, 89
Anesthesia-related factors, 716
Angiodysplasia, 59
Anismus, 20–23, 237
Anoperineal fistula, 111
Anoplasty, 115
Anorectal abscesses
antibiotics, 98
causes, 95
digital rectal examination, 95
horseshoe abscesses, 97
incontinence, 98
intersphincteric abscesses, 98
ischiorectal abscesses, 97
MRI/CT, 97
postoperatively management, 98
recurrence, 98

supralevator abscesses, 98
surgical management, 98
symptoms, 95
Anorectal and colonic evaluation
abdominal examination, 7
air-contrast study, 10
anoscopy, 7
colonoscopy, 9
computed tomography colonography, 9
CT angiography, 10
digital examination, 7
endoanal ultrasound, 11
fecal immunochemical test, 9
flexible sigmoidoscopy, 9
gastrografin enemas, 10
hemoccult testing, 9
MRI, 10, 11
multi-target stool DNA tests, 9
past medical history, 7
patient positioning, 7
radiographic studies, 9
rigid proctoscopy, 9
selective visualization via mesenteric vessels, 10
technetium-labeled scans, 10
water-soluble enema, 10
Anorectal bleeding
guide for clinicians, 61
hematochezia, 60
Anorectal Crohn's disease
adipose-derived stem cells, 130
anal fistula classification, 126, 127
antibiotics, 128
anti-tumor necrosis factor agents, 128
clinical presentation, 125
complex fistulas, 127
cryptoglandular abscess, 125
endorectal advancement flap, 130, 131
endoscopic evaluation, 125
endoscopic examination, 128
exam under anesthesia, 127
fecal diversion, 132
laser ablation therapy, 131
LIFT procedure, 129, 130
MRI, 127
open fistula plug insertion, 129
open fistulotomy, 129
proctectomy, 132
recurrence, 130
septic presentations, 125
seton placement, 128
silastic vessel loop/Penrose drain, 126
simple fistulas, 127
single perianal fistula, 125
VAAFT, 131
Anorectal evaluation
anoscopy, 5
complaints and pathologies, 3, 4
digital rectal examination, 5
endoanal ultrasound, 6
endoscopy, 5, 6
palpation of perianal skin, 5
patient history, 3, 4
physical examination, 4, 5
visualization of external aspects, 5
Anorectal manometry, 275
Anorectal pain, 3
Anorectal stricture, *see* Anal stenosis
Anorectal trauma
blunt injuries, 179
extraperitoneal rectal injuries, 181
foreign body insertion, 179
foreign body removal, 180, 181
injury identification, 179
intraperitoneal rectal injury, 182
laparotomy/diagnostic laparoscopy, 179
patient history, 179, 180
proximal diverting ostomy, 182
rectal irrigation per anus, 182
resection and primary anastomosis, 182
sphincter damage, 180
triple-phase contrast computed tomography, 179
wide debridement of non-viable tissues, 180
Anoscopy, 240
Anovaginal fistula, 111, 113
Anterior rectopexy, 225
Anterior sacral meningocele, 284
Anterior sling rectopexy, 224
Antibiotic-dependent pouchitis, 732
Antibiotics, 356
Apgar score, 42
Apocrine gland, 169, 173
Apolipoprotein A1 (apoA1), 39
Apolipoprotein B (apoB), 39–40
Appendiceal carcinoids, 595, 596, 599
Appendiceal implantation, 402
Appendiceal neoplasms
adenocarcinoma, 521
adjuvant chemotherapy, 524
AJCC staging system, 520
appendectomy, 521
carcinoid (neuroendocrine) tumors, 519
characteristics of, 520
clinical outcomes, 520
CT, 517
cytoreduction, 518, 524
endoscopy, 518
HIPEC, 524
history and physical examination, 517
incidence, 517
laboratory testing, 518
lymphoma and sarcoma, 520
MRI, 517
mucocele, 518
PET scans, 517
pseudomyxoma peritonei, 520
radiation therapy, 524
right colectomy, 523, 524
somatostatin, 524
Appendiceal tumors, 517, 518, 520
Argon plasma coagulation (APC) probe, 661, 684, 687

Arteriotomy, 550
Artificial bowel sphincter (ABS), 262
Asymptomatic intussusception, 231
Asymptomatic/unexpected DTs, 542
ATG16L1 gene, 529
Atopic dermatitis, 163–164
Attenuated FAP (AFAP), 459, 460
Atypical fissure, 81
Autoimmune-associated pouchitis, 731
Azathioprine, 530
Azithromycin, 183–185

B
Backwash ileitis, 418
Bacteroides fragilis, 189
Balloon expulsion, 241
  constipation, 275
  expulsion test, 21
Banding, 143
Bannayan-Riley-Ruvalcaba syndrome (BRRS), 587
Barium enema, 377
Basal cell carcinoma, 211
Bascom/cleft-lift technique, 155
Benign anogenital warts, 76
Benign colonic neoplasia
  ablative techniques, 456, 457
  adenomatous polyps, 451, 452
  CELS, 455, 456
  colonoscopy, 451
  EMR, 454
  endoscopic surveillance, 457
  ESD, 455
  flat polyps, 451
  hamartomatous polyps, 453
  juvenile polyps, 453
  Peutz-Jeghers polyps, 453
  serrated polyps (*see* Serrated polyps)
  surgical resection, 456, 457
  symptoms, 451
  TAE, 456
  TAMIS, 456
  TEM, 456
  treatment modalities, 453, 454
  tubular adenomas, 451
  tubulovillous adenomas, 452
  villous adenomas, 451, 452
Benzodiazepines, 384
Beta-lactam-beta-lactamase inhibitor, 191
Bethesda guidelines, 471
Bevacizumab, 312, 524
Bianchi operation, *see* Longitudinal intestinal lengthening and tailoring (LILT) procedure
Bilateral salpingo-oophorectomy (BSO), 474
Bile acid malabsorption (BAM), 704
Biofeedback, 247–249
  algorithm, 246
  clinical progress, 252
  components, 247
  constipation, 277
  contraindications, 252
  diarrhea, 268
  EMG based biofeedback, 250, 252
  fecal incontinence, 251, 257
  hardware requirements, 249, 250
  high resolution anorectal manometry, 248
  history and physical examination, 246
  internal anal sphincter, 245
  pelvic floor dysfunction, 245, 246
  pelvic floor relaxation, cognitive aspects of, 251
  sensory training, 249
  squeeze and rest anal sphincter exercises, 250
Biological active compounds, 596, 597
Bipolar contact thermal electrocoagulation probes, 683
Blended current, 685
Botox® injection, 84, 138
Botulinum toxin A, 242, 243
Bowel training, 268
Bowen's disease, 207, 210
Brachytherapy, 378, 560
B-type natriuretic peptide (BNP), 39
Budesonide (16,17α-butylidene dioxy-11β, 21-dihydroxy-1, 4-pregnadiene-3, 20-dione), 562–563
Bulbocavernosus ("Martius") flaps, 120, 121
Bulk-forming laxatives, 276
Burkitt's lymphoma, 593

C
Calcium channel blockers (CCB), 84
Candida, 189
Capecitabine, 306
Capsaicin, 166
Carbapenem, 191
Carbohydrate loading, 48
Carbon-ion radiation (CIRT), 337
Carcinoembryonic antigen (CEA), 328
Carcinoid neoplasms, 595
Carcinoid tumors, 587, 588
  algorithm, 595–603
  appendiceal carcinoids, 595
  biological active compounds, 596, 597
  chemotherapy, 603
  circulating CgA levels, 597
  clinical symptoms, 597
  desmoplastic invasion and fibrosis, 598
  diagnostic test, 597, 598
  disease extent and follow-up, 597
  echocardiogram, 598
  elective resection electrocardiogram, 598
  features and characteristics, 595
  foregut carcinoids, 597
  hepatic artery embolization, 603
  hindgut carcinoids, 595, 597
  histologic patterns, 598
  history, 595
  imaging modalities, 598
  Ki67, 597
  long-term follow-up, 603
  management, 602
  midgut carcinoids, 597

octreotide, 601
physical examination, 596
PRRT, 603
radiologic staging, 597
somatostatin analogues, 601
subtypes, 601
surgical treatment, 598
systemic therapy, 601
targeted therapy with radiolabeled somatostatin analogues, 603
tumor size, 595
upper and lower GI endoscopy, 598
Carcinomatosis, 520, 524
Cecal volvulus, 364
Cecopexy, 371
Cecostomy, 385
Ceftriaxone, 183
Cetuximab, 311, 524
Chancroid, 185
Charlson Comorbidity Index, 42
Charlson comorbidity score, 190
Chemical peristomal irritation, 637
Chemoradiation, 298
Chemotherapy
locally advanced rectal cancer, 346
recurrent rectal cancer, 337
Chemotherapy-associated steatohepatitis (CASH), 496
Chlamydia infection, 184, 185
Chlamydia trachomatis, 74, 185
Cholecystectomy, 555
Choledochojejunostomy, 555
Cholelithiasis, 701
Cholestyramine, 17, 18, 268, 704
Chordomas, 284, 288
Chronic anal fissure, 82
Chronic antibiotic-refractory pouchitis (CARP), 42, 729
Chronic intestinal injury, 558
Chronic low grade pelvic sepsis, 735
Chronic transmural inflammation, 89
"Cigarette-paper" appearance, 163
Cinedefecography, 21, 219, 241
Ciprofloxacin, 128, 185–186
Circumferential resection margin (CRM), 297, 303, 345
Circumstomal approach, 618
Cisplatin-based chemotherapy, 603
Cleveland Clinic Florida Fecal Incontinence Score (CCF-FIS), 14
Clindamycin, 191
Closed-loop obstruction, 551, 553
Clostridium difficile infection (CDI), 423
abdominal/pelvis CT scan, 444
diagnosis, 445
evaluation and management, 445
FMT, 447
medical management, 446
risk factors, 442, 444
scoring system, 441, 443, 445
treatment and prevention, 446
Coagulating current, 685
Collaborative Group of the Americas on Inherited Colorectal Cancer (CGA-ICC), 541
Colonic ileus, 365
Colonic J-pouch reconstruction, 300
Colonic malignancy, 365
Colonic perforation
algorithm, 659–665
bear claw clips, 664
cold forceps and snares, 661
EMR, 662
endoscopic management, 663
generalized peritonitis/large pneumoperitoneum, 665
hot forceps and snares, 661
iatrogenic perforation, 659, 661, 662
Instinct™, 663, 664
looping and bowing, 661
OTSC® clip, 664
OverStitch™, 664
post polypectomy syndrome, 662
QuickClip2, 664
QuickClipPro™, 664
Resolution™, 664
target sign, 662
thermal injury, 661
Colonic stricture
algorithm, 375, 376
barium enema, 377
Crohn's disease, 378
etiologies of, 377
Hinchey classification for diverticulitis, 377
history and physical examination, 375
iatrogenic causes, 378, 379
imaging, 376, 377
infectious, 378
ischemic strictures in colon, 378
laboratory tests, 375, 376
malignancy, 378
surgical intervention, 379
treatment, 379
western hemisphere, diverticulosis, 377, 378
Colonic transit, 249
Colonic volvulus, 368
Colonoscopic polypectomy, 681
Colonoscopy, 9, 297, 328, 378
Colorectal anastomotic strictures, 667
algorithm, 676
diagnosis, 677
endoscopic self-expanding metallic stents, 678
endoscopic techniques, 678
Hegar dilators, 678
imaging, 677
incidence, 675
incomplete stapler "doughnuts", 675
pathophysiology, 675
pneumatic (balloon) dilatation, 678
preoperative radiotherapy, 677
screening approach, 678
standard 15-mm rigid proctoscope, 677
standard adult flexible colonoscope, 677
symptomatic lesion, 675
symptoms, 677

Colorectal cancer (CRC)
adjuvant chemotherapy, 490
AJCC staging system, 305, 490, 491
arterial supply of colon, 489, 491
CASH, 496
chemotherapy, 497
CT scan, 495
curative resection, 498
en bloc mesocolic excision, 491, 495
en bloc resection, 491, 495
endoluminal stenting/colostomy, 498
extent of resection, 489
Griffith's point, 489
Hartmann's procedure, 498
histologic grade, 490
intraoperative colonic irrigation, 498
laparoscopic and open colectomy, 494, 495
laparoscopic surgery, 499
left hemi-colectomy, 494
long-term survival, 497
lymphadenectomy, 492
metastasectomy, 496
MRI, 495
no touch technique, 491
NOTES, 500
omental resection, 492
palliative stenting, 498
palliative surgery, 497
patient classification, 496
PCI score/index, 497
peritoneal carcinomatosis, 497
preoperative stenting, 498
prognostic factors, 497
recurrence rate, 489
retroperitoneal and intraperitoneal abdominal spaces, 489
right hemi-colectomy, 492, 493
robotic colon surgery, 499, 500
screening, 457
sigmoid colectomy, 494
single-stage procedure, 497
subtotal/total colectomy, 498
Sudeck's point, 489
surgical palliation, 499
survival rates, 496
synchronous colon cancers, 497
systemic chemotherapy, 496
temporary proximal diverting colostomy, 498
TNM system, 490, 491
treatment options, 497, 498
trocar-related complications, 499
tumor-directed resection, 498
Colorectal trauma
causes, 393
CT findings, 393
DCS techniques, 394, 395
diagnosis, 393, 394, 397
DRE, 396
EAST practice management guidelines, 397
fecal diversion, 395, 397
intra-abdominal injuries, 396
laparotomy, 394
leak rates, 395
Lembert sutures, 393
multi-detector computed tomography, 397
Organ Injury Scale, 393, 394, 396
patient co-morbidities, 395
physical examination, 397
presacral drains, 397
primary repair, 393
rectal injury scale, 397
risk factors, 395
surgical management, 397
suture repairs, 393
transfusion requirement, 395
Colposcope, 202
Columnar epithelium, 75, 77
Combined abdominal/posterior, 286–288
Combined endoscopic and laparoscopic surgery (CELS), 455, 456
Complex anorectal fistula, 127
Complex wound care, 577
Component separation techniques (CST), 580
Computed tomography (CT)
diverticulosis, 355
LBO, 363, 364
locally advanced rectal cancer, 344
rectal cancer, 297
Computed tomography angiography (CTA), 547
Condylomata, 203
Congenital-hypertrophy of the retinal pigmented epithelium (CHRPE), 463
Congenital malformations, 256
Congenital tumors, 283, 284
Coniferyl aldehyde (CA), 563
Constipation, 245, 249, 252, 271
abdominal plain films, 274
algorithm, 272–278
balloon expulsion test, 21
causes of, 271, 272
cinedefecography, 21
coexisting medical conditions, 18
defecatory disorders, 271
definition, 18
diagnosis
colon transit studies, 275
defecography, 276
endoscopy, 274, 275
history, 272, 273
labs, 274
motility studies, 275, 276
physical exam, 273, 274
radiology, 274
rectal biopsy, 276
dynamic pelvic floor MRI/MR defecography, 21
etiology, 18, 272
fiber/roughage/water intake, 18
hydrogen breath test, 20
management
biofeedback therapy, 277

conservative management, 276
manual and endoscopic disimpaction, 277
pharmacologic treatment, 276
rectal outlet obstruction, surgeries for, 278
STC, surgeries for, 277
osmotic agents, 20
outlet obstruction, 21
prevalence, 18
radiographic markers studies, 19
RAIR, 21
rectal examination, 18
rectal outlet obstruction, 20–23
rectosigmoid, 19
Rome IV criteria, 271
scintigraphy, 19
surgical options, 20
symptoms, 271
transperineal ultrasound, 22
valsalva and sphincter relaxation, 20
wireless motility capsule, 19
Contact dermatitis, 163, 165
Continent ileostomy (Kock pouch), 727
Contrast enema, 179
Controlled tissue expansion (CTE), 707
Corynebacterium minutissimum, 161
Cowden syndrome, 587
Crohn's colitis, 62
Crohn's disease (CD), 87, 89, 95, 98, 423, 588, 724, 725
anal presentations, 432
cancer risk factors, 537
classification, 432
colonic stricture, 378
complications, 433
CT enterography, 432, 530
CT scans, 432
diagnostic and therapeutic endoscopy, 434
differential diagnosis, 431
endoscopic features, 431
etiology, 431
extra-intestinal manifestations, 431
Hartmann's closure, 434
incidence, 431, 529
initial diagnosis, 530
IPAA, 434
laparoscopic surgery, 537
management
for bowel perforation, 532
endoscopic balloon dilatation, 535
external bypass, 534
external fistula, 533
Finney strictureplasty, 535, 536
for gastrointestinal bleeding, 531, 532
hand sewn end-to-end anastomosis, 533
Heineke-Mikulicz strictureplasty, 535
internal fistula, 532
ligation of thickened mesentery, 532, 534
mesenteric thickness, 532, 533
Michelassi strictureplasty, 535, 536
Moskel-Walske-Neumayer strictureplasty, 535, 536
non-resectional procedures, 533
stapled side-to-side anastomosis, 533
strictureplasty, 534, 535
medical management, 530
medical treatment, 433, 434
minimally invasive approach, 434
MR enterography, 432, 530
operative indications, 530, 531
pathogenesis, 529
phenotypes, 431
postoperative abscess, 537
postoperative intra-abdominal septic complications, 537
recurrence prevention, 537
refractory inflammation, 530
risk factors, 529
serological biomarkers, 432
stricturing and penetrating patterns, 529
stricturoplasty, 434
surgical treatment, 434
symptoms, 431
Crohn's proctitis, 114
Cryptoglandular abscess, 125
Cryptoglandular fistula, 101, 105, 107
Cryptoglandular infections, 95
Cuffitis, 725
Cyclooxygenase (COX) inhibitors, 589
Cystocolpodefecography, 21
Cystogram, 357
Cytoreductive debulking surgery, 602
Cytoreductive surgery (CRS), 515

D
Dacarbazine, 541
Damage control laparotomy, 575
da Vinci® SI surgical robot, 697
DECREASE V trial, 42
Deep parenchymal laceration, 657
Defecatory disorders, 271
Defecography, 229, 231, 232, 234, 257
constipation, 276
diarrhea, 267
pelvic outlet obstruction, 241, 242
Definitive abdominal closure, 575
Defunctioning loop ileostomy, 721
Delayed ureter injury, 649
Dentate line, 207
Desmoid perforation, 542
Desmoid precursor lesion, *see* Desmoid reaction
Desmoid reaction, 539, 540
Desmoid tumors (DTs), 463
asymptomatic/unexpected DTs, 542
CGA-ICC staging, 541
clinical behavior, 539
CT, 540
definition, 539
desmoid reaction, 539
enterocutaneous fistulae, 542
FAP, 540, 541

Desmoid tumors (DTs) (*cont.*)
IAD risk factors, 540
incidence, 539
MDCT, 540
morbidity, 541
MRI, 540
pregnancy and, 542
small bowel obstruction, 542
symptoms, 539
trauma and estrogen exposure, 541
treatment
algorithm, 540
anti-estrogen agent, 541
cytotoxic chemotherapy, 541
NSAIDS, 541
sulindac, 541
surgery, 541
Detachable nylon loop ligation device, 688
Developmental cysts, 283
Diarrhea, 441
algorithm, 267–269
anal manometry, 266
anal plug, 268
bowel training, 268
Bristol Stool Scale, 267
defecography/MRI defecography, 267
dietary modification, 267
endoanal ultrasound, 267
evaluation, 265, 266
fecal incontinence, 265, 266
fiber supplement, 268
management algorithm, 268
medicines, 268
non-absorbable bulking agents injectable, 269
patient evaluation, 265
pelvic floor dysfunction, 265, 266
pelvic floor exercises and biofeedback, 268
PTNML, 266
SECCA procedure, 268
skin barriers and creams, 268
surgery, 269
Dietary fiber, 353
Diffuse reflectance spectroscopy (DRS), 648
Digital rectal examination (DRE)
locally advanced rectal cancer, 343
rectal cancer, 321
Diltiazem, 143
Diphenoxylate, 268
Disseminated intravascular coagulation (DIC), 447
Diverticular abscesses, 356
Diverticular disease, 353
Diverticulitis, 365
Diverticulosis
acute uncomplicated, 355, 356
algorithm, 354
antibiotics, 356
clinical presentation, 355
colon, endoscopic evaluation of, 358
colonic stricture, 377, 378
colostomy reversal, rates of, 358
computed tomography, 355
dietary fiber and, 353
diverticular strictures, 356
elective resection, 357
fistulas, 357
Hinchey classification system, 355
immunocompromised patients, 358
laparoscopic approaches, 358
mechanism of progression, 354
modified Hinchey classification, 355
non-dietary theories, 354
presence of, 353
presenting with complicated, 356
risk factors for recurrence, 357
SEMS, 357
sigmoid resection, 356
Diverting loop ileostomy and intra-operative colonic lavage (DLI + ICL), 427
Diverting stoma, 675
Doxorubicin, 541
Doxycycline, 185
Dressing care, 716, 717
Dual antiplatelet therapy (DAPT), 43
Duke Activity Status Index, 39, 40
Duodenal polyps, 585, 587
Dynamic defecating proctography, 21
Dyspareunia, 399
Dysplasia-associated lesion or mass (DALMs), 408
Dyssynergia, 271

E

Early anastomotic complications
bleeding, 672, 673
intra-abdominal anastomotic leak
algorithm, 667–671
classic and soft signs, 667
CT scan, 669
damage control measures, 670
with generalized peritonitis/severe sepsis, 670
inflammation and adhesions, 670
localized abscess, 667
localized peritonitis, 669
location of, 667
management strategies, 667–669, 671
open management with delayed abdominal closure, 670
operative factors, 667
operative intervention, 669
patient and disease factors, 667
percutaneous drainage, 669
preoperative evaluation, 669
proximal segment of bowel, 670
stable vital signs, 669
standardized post-operative surveillance protocols, 667
subclinical leaks, 667, 669
pelvis, 671, 672
Elective/semi-elective sigmoid, 372
Electrocautery, 688

Electrocoagulation injury, 689
Electrocoagulation techniques, 684
Electrolytes, 383
Electromyography (EMG), 241, 250
Electrosurgical and electrocautery tools, 686–687
Electrosurgical currents, 685
Electrosurgical generator unit (ESGU), 685
Emergency GI hemorrhage, 567
Endoanal ultrasound, 267
Endoclips, 687
Endometriomas, 286
Endometriosis
  appendiceal implantation, 402
  bowel involvement, 399
  combined therapy, 403
  diagnosis, 401
  full-thickness disc excision, 403
  GnRH-a, 402
  indications, 402
  intestinal endometriosis, 403
  laboratory evaluation, 399
  noninvasive testing, 399, 401
  oral contraceptives, 402
  ovarian masses, 399
  pain causes, 399
  pathogenesis, 399
  physical examination, 399
  preoperative medical therapy, 403
  prevalence, 399
  prophylactic antibiotics, 402
  rectosigmoid endometriosis, 403
  robot-assisted laparoscopy, 401
  segmental resection, 403
  small bowel and appendiceal endometriosis, 402
  surgical techniques, 402
  surgical therapy, 403
  symptoms, 399
  treatment, 402
Endorectal ultrasound (ERUS)
  constipation, 275
  locally advanced rectal cancer, 345, 346
  rectal cancer, 297
Endoscopic balloon dilation, 379, 725
Endoscopic decompression, 384
Endoscopic mucosal dissection (ESD), 687
Endoscopic mucosal resection (EMR), 687
Endoscopic stenting, 317
Endoscopic submucosal dissection (ESD), 659
Endoscopy
  constipation, 274, 275
  retrorectal tumors, 282
Endosonography, 258
Endovascular interventions, 633
End-to-end sphincteroplasty, 258
Enhanced recovery after surgery society (ERAS), 31, 715
Enhanced Recovery in NSQIP (ERIN), 53
Enhanced recovery pathways (ERP)
  electronic medical records, 53
  intraoperative management
    analgesia, 49
    anesthesia role, 50
    fluid homeostasis, 48, 49
    minimally invasive colorectal surgery, 48
    nasogastric tubes, 50
    surgical site infections prevention, 50
    venous thromboembolism prophylaxis, 49
  postoperative recovery
    analgesia, 51
    coordination of care, 53
    discharge criteria, 52
    early ambulation, 52
    early oral feeding, 51, 52
    follow-up, 53
    intravenous fluid management, 51
    multimodal pain management, 51
    postoperative ileus, 52
  preoperative management
    carbohydrate loading, 48
    fasting, 47
    frailty, 47
    goals, 46
    immunonutrition, 46
    lifestyle modifications, 47
    malnutrition, 46
    MBP, 47
    nutritional optimization, 46
    patient education and engagement, 45, 46
    prehabilitation, 47
    SGA, 46
  safety and efficacy, 53
  treatment algorithm, 45
Enteral feeds, 704
Enteral nutrition, 576, 577
Enteroatmospheric fistula (EAF)
  classification, 573
  complications, 573
  damage control laparotomy, 575
  diagnosis, 573
  effective wound management, 577
  enteral nutrition, 576
  immediate attention, 575
  parenteral nutrition, 576
  post-surgical patient, 576
  surgical intervention, 575
Enterobius vermicularis, 162, 163
Enterocutaneous fistula (ECF), 542, 569, 570, 699
  abdominal wall reconstruction, 579
  aggressive non-operative management *vs*. definitive surgical intervention, 575
  classification, 573, 575
  completely laparoscopic techniques, 580
  complex wound care, 577
  complication, 573
  component separation techniques, 580
  damage control laparotomy, 575
  definitive abdominal closure, 575
  definitive reconstruction, 579
  diagnosis, 573
  dynamic and functional abdominal wall, 580, 581

Enterocutaneous fistula (ECF) (*cont.*)
edematous bowel, 575
effective wound management, 577
endoscopic clips, 579
enteral nutrition, 576, 577
external oblique aponeurosis, 580
fibrin sealant, 579
fistula plugs, 579
fluid resuscitation, 576
formation, 609
functional abdominal wall, 581
immediate attention, 575
intra-abdominal sources, 576
management algorithm, 573–581
modified component separation techniques, 580
negative pressure devices, 575
negative pressure wound therapy, 577
parenteral nutrition, 576, 577
peri-wound skin care, 578
pinch test, 578, 579
posterior component separation, 580
posterior rectus sheath, 580
principles, 577
re-fistulization, 576
retrorectus dissection, 580
sepsis control, 576
severity, 573
vs. small and controlled fistula, 574
well-organized multidisciplinary approach, 573
wound and fascial dehiscence, 573
wound manager, 578
Enteroenteric fistula, 533
Enteropathy-associated T cell lymphoma (EATL), 591
Enterostomal therapists (ET), 636
Epidermoid cyst, 283
Episioproctotomy, 115, 116
Epithelial cell injury, 557–558
Escherichia coli, 189
Esophagogastroduodenoscopy (EGD), 731
Estimation of Physiologic Ability and Surgical Stress (E-PASS) scoring system, 42
Etiopathogenetic pathways, 729
EVARREST® Fibrin Sealant Patch, 697
Ex vivo 3D cultures/enteroid systems, 557
Excisional hemorrhoidectomy, 143, 147–149
Extensive bowel resection, 701
Extensive/refractory Crohn's disease, 725
External beam radiotherapy (EBRT), 378, 514
External hemorrhoids
acute thrombosis, 146
anoscopy, 146
bleeding, 146
clinical presentation, 146
evaluation, 147
history and physical examination, 146
quality of life, 146
symptoms, 145
thrombosed external hemorrhoids, 145
treatment
conservative management, 147, 148
excisional hemorrhoidectomy, 147
External oblique aponeurosis, 580
Extracolonic manifestations, 407
Extramesorectal disease, 304
Extrasphincteric fistula, 126, 127

F

Familial adenomatous polyposis (FAP), 539–542, 585, 729
adrenal adenoma and carcinoma, 462
and AFAP, 459, 460
CHRPE, 463
colectomy with ileorectal anastomosis (IRA), 464
colonoscopy, 461
colorectal cancer, 460
de-novo mutations, 459
desmoid tumors, 463
duodenal cancer, 461
epidermoid cysts and fibromas, 462
etiology, 459
extracolonic manifestations, 461
fertility/fecundity, 465
fundic gland polyps, 461
genetic testing and counselling, 459
hepatoblastoma, 462
incidence, 459
intra-abdominal desmoids, 465
laparoscopy, 464
management, 459, 460
MYH-associated polyposis, 459
osteomas and supranumerary teeth, 462
prevalence, 459
restorative proctocolectomy with ileal pouch anal anastomosis (IPAA), 463, 464
small bowel adenomas and carcinomas, 461
Spigelman criteria, 462
surveillance, 461
thyroid cancer, 462
timing of surgery, 465
total proctocolectomy with end-ileostomy, 464
treatment strategies, 463
Turcot syndrome, 463
FAP- associated pouchitis, 729
Fasting, 47
Fecal diversion, 635
Fecal immunochemical test (FIT), 9
Fecal incontinence (FI), 129–132, 246
algorithm, 256
anal manometry, 15
anatomic etiology, 257
biofeedback, 17, 251
Cleveland Clinic Florida Fecal Incontinence Score, 256
diarrhea, 265
diet and medical management, optimization of, 256
biofeedback, 257
dietary modifications, 257
fiber supplementation, 257
medications, 257

digital examination, 14
endoanal ultrasound, 15, 16
etiology, 13
gastrointestinal/anorectal physiology testing, 15, 16
graciloplasty, 261
history and physical examination, 15, 255, 256
obstetric history, 13
ostomy, 262
injectables, 262
RF remodeling, 263
physiologic testing, 14, 17, 19
PNTML, 17
prevalence, 13
sacral nerve stimulation, 17, 260
SNS, 259, 260
tibial nerve stimulation, 260
sphincter replacement, 261
ABS/ MAS, 262
gluteoplasty, 261
graciloplasty, 261
sphincteroplasty, 18, 258, 259
end-to-end sphincteroplasty, 258
overlapping sphincteroplasty, 258, 259
surgical history, 13
suspected recent sphincter injury, 258
Fecal microbiota transplant (FMT), 446, 447
Fecal/urinary diversion, 635
Fermentable oligosaccharides, disaccharides, monosaccharides and polyols (FODMAPs), 390
Fiber diet, 83
Fibrin sealant, 579
Finney strictureplasty, 535, 536
Fissurectomy, 139
Fistula-in-ano
anal mass, 76
complex fistulas
extrasphincteric fistula, 105
high transsphincteric fistula, 104
suprasphincteric fistula, 104
cryptoglandular fistula, 101
CT scan, 102
cutting procedures/non-sphincter sparing procedure, 105
fistulectomy, 105
fistulotomy, 105
draining setons, 107
endorectal advancement flaps, 106
EUS, 102
incidence, 101
LIFT procedure, 106
MRI, 102
Park's classification, 102
physical examination, 101, 102
recurrence, 106
simple anal fistulas
intersphincteric fistulas, 103
transsphincteric fistulas, 103
sphincter-sparing procedures, 105
surgical treatment principles, 105, 107
symptoms, 101
VAAFT, 106
Fistula Laser Closing (FiLAC™) device, 106
Fistulas, 357
Fistula tract, 76
Fistulectomy, 105
Fistulotomy, 105
Flat polyps, 451
Floxuridine, 524
Fluid resuscitation, 576
5-Fluorouracil (5-FU), 214, 306
Foregut carcinoids, 597
Fournier's gangrene (FG), 143
abdominoperineal resection, 192
adjunctive treatment, 191
antibiotics, 191
colostomy, 192
fecal diversion, 192
FGSI, 190
incidence, 189
LRINEC, 191
management algorithm, 190, 192
mortality predictors, 190
pelvic imaging, 192
polymicrobial infection, 189
primary cancer resection, 192
risk factors, 190
serial surgical debridement, 191
symptoms, 190
Fournier's Gangrene Severity Index (FGSI), 190
Frailty, 47
Free flap closure, 198
Full thickness rectal prolapse, 75
Full thickness stomal prolapse, 607, 609
Functional stenosis, 89
Fundic gland polyps, 461

G

Gastritis, 59
Gastrografin enemas, 10
Gastrointestinal (GI) continuity, 705
Gastrointestinal lymphoma, 588
Gastrointestinal mucosal immunity/integrity, 576
Genetic syndrome, 584
Glisson's capsule, 524
Glucagon-like peptide-2 (GLP-2), 705
Gluteoplasty, 261
Goblet cell appendiceal carcinoids, 523
Goblet cell carcinoids, 517, 520
Gonococcal infection, 184
Gonorrhea, 183
Goodsall's rule, 76
Gracilis flap, 198
Gracilis interposition, 120
Gracilis muscle flap, 199
Graciloplasty, 261
Granuloma inguinale (donovanosis), 185

H

H2 blockers, 704
Haemophilus ducreyi, 185
Haggitt's classification, 479
Hamartomas, 586
Hamartomatous polyps, 453
Hand-assisted laparoscopy, 656
Hand-sewn anastomosis, 727
Hanley procedure, 97
Hartmann's end colostomy, 372
Hartmann's procedure, 356, 358, 498
Heated intraperitoneal chemotherapy (HIPEC), 515, 518, 524
Heineke-Mikulicz strictureplasty, 535
Heineke–Mikulicz technique, 136, 137
Hemangiomas, 59
Hematochezia
  anorectal bleeding, 60
    anal mass, 59
    colonoscopic findings, 62
    fissure, 59
    hemorrhoids, 59
    proctitis, 59
    pruritus, 59
  definition, 55
  minor/moderate hematochezia, 55
    anoscopy, 55
    flexible sigmoid proctoscopy, 55
  severe hematochezia
    angiography, 62
    anticoagulant therapy/NSAIDS, 56
    clinical examination, 56
    enteroscopy, 62
    radionucleotide testing, 62
    resuscitation, 55
    surgery, 62
    upper endoscopy, 57
Hematuria, 647
Hemoccult testing, 9
Hemolytic uremic syndrome (HUS), 378
Hemophilus ducreyi, 74
Hemorrhoid artery ligation, 143
Hemorrhoidectomy, 87, 94
Hemorrhoid mucosal prolapse, 221
Hemorrhoids, 59
  incidence, 145
  initial evaluation, 141
Hepatic arterial infusion pump (HAIP) therapy, 318
Hepatic artery embolization, 603
Hereditary Nonpolyposis Colorectal Cancer (HNPCC), 469, 585
Hernias, 553
Herpes simplex virus 1 and 2, 186
Hidradenitis suppurativa (HS)
  algorithm, 169–175
  biopsy, 170
  comorbid disorders, 171
  depression and sexual dysfunction, 173
  diagnosis, 169
  dietary triggers, 169
  differential diagnosis, 170
  HiSCR, 171, 172
  Hurley classification system, 170, 172
  inflammatory nodules, 169
  MRI, 170
  pathophysiology, 169
  perianal HS, 169
  physical examination, 169
  prevalence, 169, 172
  recurrence rates, 173
  risk factors, 169
  SCC, 172
  treatment
    adalimumab and infliximab, 173
    clindamycin and rifampin, 172
    life style modifications, 172
    recurrence rate after surgery, 173
    retinoids, 173
    surgical management, 173
    systemic antibiotherapy, 172
    topical antibiotherapy, 172
  ultrasonography, 170
Hidradenitis Suppurativa Clinical Response (HiSCR), 170–172
High-grade dysplasia, 408
High sensitivity C-reactive protein (hsCRP), 39
High transsphincteric fistula, 104
Hill-Ferguson anal retractor, 87, 89
Hindgut carcinoids, 595, 597
Hirschsprung's disease, 21, 87
Holy Plane of dissection, 299
Horseshoe abscesses, 95, 97, 98
Hospital acquired conditions or infections (HAC/HAI), 711
Hot biopsy forceps (HBF), 686
Human immunodeficiency virus (HIV), 183–186
Human papilloma virus, 76, 186, 187
Hurley classification system, 170
Hurley clinical staging system, 172
Hydrogen breath test, 20
5-Hydroxyindoleacetic acid (5-HIAA), 519, 597
Hyperbaric oxygen therapy, 732
Hyperparathyroidism, 18
Hyperplastic polyps, 452
Hyperspectral camera technology, 648
Hypertrophied anal papillae, 75
Hypothyroidism, 18

I

Iatrogenic bowel injury, 578
Iatrogenic colonic perforations, 659
Iatrogenic genitourinary injury repairs, 649
Iatrogenic perforation, 659, 661, 662
Iatrogenic splenic injury
  algorithm, 652
  anatomy, 651
  co-morbidities, 653

hand-assisted laparoscopy, 656
incidence, 651, 653
ligaments, 651
limitation, 656
management, 656, 657
mechanisms of injury, 653, 654
mesocolon /appendix epiploica, 656
mobilization of splenic flexure, 655
vs. open, laparoscopic colorectal surgery, 654
prevention, 654
risk factors, 651, 653
spleen attachment, 651, 653
splenic flexure, 651, 653
splenic laceration with hemostatic agent, 657
univariate regression analysis, 653
Iatrogenic ureteral injury (IUI), 649
algorithm, 643–649
anastomotic repair, 649
concurrent intraoperative (*vs*. preoperative) placement, 647
definitive visualization, 643
delayed ureter injury, 649
iatrogenic genitourinary injury repairs, 649
illuminated/lighted ureteral catheters, 647
image-guided surgery, 648
incidence, 643
inferior mesenteric artery, 644, 645
informed consent process, 643
intraoperative ureter injury, 645, 646
left ureter, 644, 645
lighted stent, 647
meticulous surgical technique, 643
non-invasive methods, 648
post-operative complications, 647
prevention, 647
prophylactic ureteral catheters, 647
retroperitoneal anatomy, 643
right ureter injury, 644, 646
robotic approach, 643
transected ureter, 644
tubularized bladder, 648
ureteral catheterization, 647
urinary diversion, 648
Ileal advancement flap, 115
Ileal pouch anal anastomosis (IPAA)
abdomino-pelvic IPAA revision, 726
adhesiolysis, 726
complications, 719
Crohn's disease, 724, 725
cuffitis, 725
definition, 719
delayed perineal wound healing, 727
dysplasia and cancer, 726
early septic complications, 720, 723
endoscopic balloon dilation, 725
functional outcomes, 421
hand-sewn anastomosis, 727
in IBD colitis patient, 419
intersphincteric approach, 727
intra-operative pouch ischemia, 721
intraoperative ureteral stents, 726
laparoscopic technique, 409–411
long-term outcomes, 420
mechanical and enteral antibiotics, 409
mesenteric rents, 411
minimally invasive robotic and laparoscopic IPAA, 719
minimally invasive techniques, 409
modifiable patient risk factors, 719
open technique, 411, 412
pelvic sepsis, 721, 722, 724
perianal fistulizing disease, 722, 725
periodic surveillance, 727
postoperative complications, 420
pouch prolapse, 726
pouch sinus, 724
pouchitis, 723, 725
Pouchitis Disease Activity Index, 725
pouch-vaginal fistula, 721, 724
septic/inflammatory, 726
with subtotal colectomy and end ileostomy, 419
tension-free anastomosis, 720
total abdominal colectomy, 420
transanal mucosectomy, 726
ventral pouchpexy with fixation, 726
Ileoanal pouch-vaginal fistulas, 115, 119
Ileocecal valve (ICV), 701
Ileorectal anastomosis (IRA), 415
indeterminate Colitis, 415
postoperative management, 415
refractory symptoms, 415
surveillance, 415
Ileosigmoid fistula, 533
Ileostomy reversal, 312
Illuminated/lighted ureteral catheters, 647
Imiquimod, 203
Immunonutrition, 46
Immunoproliferative small intestinal disease (IPSID), 591
Indeterminate Colitis (IC), 415, 419
colonoscopy, 417
CT/MR enterography, 417
diagnosis, 418
histological features, 418
IPAA (*see* Ileal pouch anal anastomosis)
macroscopic features, 418, 419
microscopic features, 420
mucosal biopsies, 418
open /minimally invasive surgical techniques, 419
physical examination, 417
proctolectomy, 420
proctectomy, 419
published series, 421
serological biomarkers, 417
stool testing, 417
symptoms, 417
treatment, 418
Index surgery, 332

Infectious colitis
abdominal/pelvis CT scan, 441
antimicrobial therapies, 445
antimicrobial treatment, 441, 443
broad spectrum intravenous antibiotics, 448
causes, 441, 442
CDI (*see Clostridium difficile* infection)
cell culture cytotoxicity assay, 446
CT findings, 447
flexible endoscopy, 446
FMT, 446
GDH EIA screening tests, 446
ICU admission, 448
imaging studies, 446
indications for emergent operation, 448, 449
infectious agents, 441
in-hospital mortality, 448
initial laboratory evaluation, 444
intravenous fluid resuscitation, 448
marked leukocytosis, 447
mechanical ventilator support, 448
mental confusion and disorientation, 447
ominous signs/indications, 446–448
respiratory distress, 447
risk factor, 443
scoring systems, 441
stool studies, 444
supportive care, 445
systemic antibiotics, 446
Infectious colonic strictures, 378
Infectious dermatitis, 638
Inferior mesenteric artery (IMA), 625, 644, 645
Inferior mesenteric vein (IMV), 645
Inflammatory bowel disease (IBD), 444, 591
Inflammatory bowel disease– unclassified (IBD-U), 418
Inflammatory Bowel Disease Unspecified (IBDU), 415
Inflammatory proctocolitis, 441
Inflammatory response, 558
Infliximab, 128, 129
Inherited hamartomatous polyposis syndrome, 586
Injection sclerotherapy, 632
Instinct™, 663, 664
Intensity-modulated radiotherapy (IMRT), 559
Internal hemorrhoidal disease, 59
Internal hemorrhoids, 145, 146
counseling patients, 142
cryotherapy, 143
excisional hemorrhoidectomy, 143
grading, 141
hemorrhoid artery ligation, 143
isosorbide dinitrate, 142
lifestyle modification, 141
phlebotonics, 142
rubber-band ligation, 143
sclerotherapy, 143
stapled hemorrhoidopexy, 143
topical steroids, 142
Internal intussusception, 229
algorithm, evaluation and management, 230
diagnostic studies, 230
history and physical examination, 230
Intersphincteric abscesses, 98
Intersphincteric approach, 727
Intersphincteric fistulas, 103
Interstitial/intra-cavitary brachytherapy, 560
Intestinal crypt epithelial cells, 557
Intestinal endometriosis, 403
Intestinal failure (short bowel syndrome), 569
Intestinal homeostasis (IH), 557
Intestinal lymphoma, 593
Intestinal stem cell (ISC), 557
Intestinal stoma, 243
Intestinal transplant, 707
Intra-abdominal anastomotic leak
algorithm, 667–671
classic and soft signs, 667
CT scan, 669
damage control measures, 670
with generalized peritonitis or severe sepsis, 670
inflammation and adhesions, 670
localized abscess, 667
localized peritonitis, 669
location of, 667
management strategies, 667–669, 671
open management with delayed abdominal closure, 670
operative factors, 667
operative intervention, 669
patient and disease factors, 667
percutaneous drainage, 669
preoperative evaluation, 669
proximal segment of bowel, 670
stable vital signs, 669
standardized post-operative surveillance protocols, 667
subclinical leaks, 667, 669
Intra-abdominal carcinomatosis, 555
Intracardiac thrombus, 547
Intra-operative pouch ischemia, 721
Intraoperative ureter injury, 645, 646
Invasive anal canal neoplasia
anal adenocarcinoma, 216
anal melanoma, 215
clinical response, follow-up, 215
C-XR, 215
documented regression and subsequent complete clinical response, 215
history and physical examination, 213
incidence, 213
locoregional disease, treatment for, 214
metastatic disease, 214
metastatic workup, 214
pathologic diagnosis, 213
persistent disease, 215
presentation, 214
SCC, 213, 214

surgical management, 215
symptomatology, anal sarcomas mimic, 216
Invasive chondrosarcoma, 286
Ionizing radiation, 557
Irritable bowel syndrome (IBS)
acupuncture, 390
antidepressants, 390
antispasmodic agents, 390
classification, 387
diagnostic workup and treatment, 387–389
dietary and lifestyle modifications, 390
differential diagnosis, 389
endoscopy, 389
history and physical examination, 389
imaging studies, 389
pathology, 387
prevalence, 387
psychiatric illness and personality pathology, 389
psychotherapy, 390
quality of life scores, 391
risk factors, 389
Rome III criteria, 389
SNS, 390
symptoms, 388
Irritable pouch syndrome (IPS), 726, 731
Ischemia-associated pouchitis, 732
Ischemic colitis
bowel anastomosis, 440
diagnosis, 437
end colostomy/ileostomy, 440
imaging, 439
incidence, 437
laboratory investigations, 437
laparotomy, 440
management, 439, 440
pathognomonic biopsy findings, 439
risk factors, 437
symptoms, 437
Ischemic ileum, 549
Ischemic pouchitis, 731
Ischemic strictures, 378
Ischiorectal abscesses, 97, 98
Isoperistaltic colonic interposition, 706
Isosorbide dinitrate, 142

J
Jejunostomy patients, 702
Jejunum-colon anastomosis, 701
Jejunum-ileum, 702
Juvenile Polyposis syndrome (JPS), 587
Juvenile polyps, 453

K
Kaplan-Meier analysis, 131
Karydakis flap, 155
Keyhole technique, 613, 614
Ki67, 597
Klebsiella granulomatis, 185

L
Laboratory Risk Indicator for Necrotizing Fasciitis (LRINEC), 191
Lactophenol, 162
LaPlace's law, 382
Large-bowel obstruction (LBO)
abdominal examination, peritoneal signs on, 364, 365
acute colonic volvulus, 365
acute diverticulitis, 365
algorithm, 363, 364
cecal volvulus, 364
colonic ileus, 365
colonic malignancy, 365
diverticulitis, 365
intussusception, 365
Ogilvie's syndrome, 366
potential morbidity and mortality, suspicion, 363
radiographic studies, 363
Large squamous cell carcinoma, 209
Late anastomotic complications
sinus tracts
algorithm, 676
asymptomatic, 677
diverting stoma, 675, 677, 679
incidence, 675
management, 678
multiple anastomotic, 679
pathophysiology, 675
stricture
algorithm, 676
diagnosis, 677
endoscopic self-expanding metallic stents, 678
endoscopic techniques, 678
Hegar dilators, 678
imaging, 677
incidence, 675
incomplete stapler "doughnuts", 675
over-healing formation, 675
pathophysiology, 675
pneumatic (balloon) dilatation, 678
preoperative radiotherapy, 677
screening approach, 678
standard 15-mm rigid proctoscope, 677
standard adult flexible colonoscope, 677
symptomatic lesion, 675
symptoms, 677
Lateral internal sphincterotomy (LIS), 84, 138
Lay-open fistulotomy technique, 76
Leiomyomas, 59
Lembert sutures, 393
Leukocyte activation, 558
Levatorplasty, 221, 222
Lichen sclerosis, 163, 164
Lichen simplex chronicus, 163, 164
Lidocaine, 84, 147
Lifting technique, 688

Ligation of the intersphincteric tract (LIFT) procedure, 106, 129
Limberg/rhomboid flap, 156
Linaclotide, 277
Linaclotide, 20
Linzess®, 390
Liposome bupivacaine, 143
Liver metastasectomy, 602
Local flaps, 198
Localized peritoneal irritation, 689
Locally advanced colon cancer
AJCC definitions, 503, 504
Anatomic Stage/Prognostic Groups, 503, 505
appendiceal neoplasm, 506
Boari flap, 506
chemotherapy and/or radiation, 508
colonoscopy with biopsy, 505
computed tomography, 505
duodenal invasion, 507
en bloc resection, 506
hydroureter, 506
infectious complications, 506
invasion of major vessels, 506
left colon cancers, 507
operative planning, 505
preoperative cystoscopy, 505
preoperative determination, 506
preoperative endoscopic evaluation, 506
preoperative imaging and endoscopy, 505
preoperative staging, 505
psoas hitch procedure, 506
sigmoid colon cancers, 507
symptoms, 505
T4a cancers, 503
T4a tumors, 507
T4b tumors, 503, 507
ureteral invasion, 506
Locally advanced rectal cancer
algorithm, 341, 342
chemotherapy and radiation therapy, 346
colonoscopy, 344
computed tomography, 344
curative resection, metastatic disease after, 347
DRE, 343
endorectal ultrasound, 345
endoscopic screening programs, 343
ERUS, 345, 346
imaging studies, 344, 345
magnetic resonance image, 345
neoadjuvant chemoradiation, 347
routine laboratory tests, 344
short-course radiation therapy, 347
stage II and III disease, 341
surgery, surveillance after, 349
Locoregional disease, treatment for, 214
Lomotil, 17, 704
Lone Star® Retractor, 221
Longitudinal intestinal lengthening and tailoring (LILT) procedure, 706
Loop stomal prolapse, 607, 609
Loperamide, 17, 163, 268, 704
Low anterior resections (LAR) syndrome, 300
Low molecular weight heparin (LMWH), 49
Low transsphincteric/uncomplicated intersphincteric fistulas, 76
Lubiprostone, 20, 277
Lugol's solution, 202
Lymph node metastasis, 289–290
Lymphogranuloma venereum, 185
Lymphoma, 520
Lymphoma mass/debulking procedures, 593
Lynch syndrome
Amsterdam criteria, 469, 472
Bethesda guidelines, 471
colonoscopy and polypectomy, 475
common cancers, 469
definition, 469
diagnosis, 471
EPCAM mutation, 469
etiology, 469
evaluation and management, 470
extracolonic risk reduction, 475, 476
gene mutations, 469
genetic counseling, 472
genetic testing, 472
MMRd, 471
personal and family history, 470, 471
surgical management
decision making, 472, 473
education and evaluation, 474
extended colectomy, 472
multimodality therapy, 473
post-operative surveillance, 474
preoperative pelvic radiation, 473
proctectomy, 473
randomized prospective trials, 472
segmental colectomy, 472, 474
segmental resection, 473, 474
TAH/BSO, 474
tumor testing, 471

M

Macrodebridement, 197
Magnetic anal sphincter (MAS), 261, 262
Magnetic resonance imaging (MRI)
locally advanced rectal cancer, 344, 345
rectal cancer, 297, 303
Malignancy, 378
Malignant colon polyps
colectomy, 482
degree of differentiation, 481
grades of differentiation, 481
malignant polyp, 479
management, 481
microstaging, 482
morphology, 479
NCCN surveillance, 482
non-invasive polyps, 479
pedunculated polyp, 479–481

sessile polyp, 481
Malignant melanoma, 211
Mallory Weiss tears, 59
MALT-associated lymphoma, 591
Manometry, 241
Martin's anoplasty, 91
Martius flaps, 120, 121
Mebendazole, 162
Mechanical bowel preparation (MBP), 47
anastomotic leak, 25
cancer recurrence risk, 30, 31
Clostridium difficile infection, 30
incidence, 25
laparoscopic colon and rectal surgery, 29
low rectal/coloanal anastomosis, 28, 29
meta-analysis of randomized controlled studies, 31
meta-center studies
anastomotic leaks and wound infections, 32
oral antibiotics, 32
polyethylene glycol, 32
postoperative complications, 32
SSI risk, 33
oral antibiotics, 30
postoperative surgical site infection, 25
single center studies
abdominal infectious complications, 27
anastomotic leak, 27
infection rate, 28
ileo-colonic anastomosis, 27
intra-abdominal infection rate, 26, 27
polyethylene glycol, 27
wound infection, 26, 27
small lesions localization, 28
spillage control, 30
usefulness, 25
wound infection, 29, 31
Mechanical peristomal injury, 637, 638
Meckel's diverticulum, 62
Melena
definition, 55
evaluation, 56, 60
upper gastrointestinal bleeding
mass, 59
non-variceal, 57, 59
pre-malignant/malignant lesion, 57
variceal, 57
6-Mercaptopurine, 530
Mercedes technique, 618, 620
Mesenteric ischemia
acute embolism, 548
acute thrombosis of mesenteric arteries, 548
algorithm, 545–550
antibiotics, 549
cardiac evaluate, 547
clinical presentation, 545
evaluation, 545, 546
history, 546
ischemic ileum, 549
IV access, 549
laboratory studies, 546
ligament of Treitz, 550
mesenteric venous thrombosis, 548
nonocclusive mesenteric ischemia, 548, 549
nutritional status, markers of, 547
occlusive mesenteric ischemia, 549
physical examination, 546
proximal and distal control, 550
radiologic evaluation, 547
risk factors, 545
signs and symptoms, 546
SMA embolism, 549
SMA thrombosis, 550
therapeutic anticoagulation, 549
vascular reconstruction, 550
venous thrombosis, 550
Mesenteric venous thrombosis, 548
Mesoappendix, 599
Mesosigmoidoplasty, 370
Meta-iodobenzylguanidine scan (MIBG), 598
Metastatic carcinoid disease, 602
Metastatic rectal cancer, 309–312
Methotrexate, 541
Metronidazole, 128
Microbiota-associated pouchitis, 731
Microdebridement, 197
Midgut carcinoids, 597
Minimally invasive techniques, 301
Mismatch repair (MMR) genes, 585
Mismatch repair deficiency (MMRd), 471
Misoprostol, 277
Mitigators/treatment agents
cholestyramine, 562
glutamine, 562
pentoxifylline, 562
sulfasalazine, 562
tocopherol, 562
Mitomycin C (MMC), 214, 524
Modified Frailty Index (mFI), 47
Molluscipox virus, 187
Molluscum contagiosum, 187
Moskel-Walske-Neumayer strictureplasty, 535
Mucinous adenocarcinoma, 517, 521
Mucocele, 518
Mucocutaneous disconnection (MCD), 633
Mucosal biopsy, 731
Mucosal ectropion, 89
Mucosal inflammation, 731
Mucosal proctosigmoidectomy, 278
Mucosal sleeve resection, 222, 223
Mucosectomy, 738
Multidisciplinary tumor (MDT), 233, 234, 312
Multi-organ prolapse, 231
Multi-target stool DNA tests, 9
MutYH-associated polyposis (MAP), 585
MYH-associated polyposis, 459

N

National Comprehensive Cancer Network, 472
National Healthcare Safety Network, 711

National Polyp Study, 483
Natural orifice transluminal endoscopic surgery (NOTES), 500
Necrotic prolapsed stoma, 607, 609
Necrotizing soft tissue infection (NSTI), 189, 191
Needle electrodes, 266
Negative-pressure wound dressings (NPWD), 197
Negative pressure wound therapy (NPWT), 577
Neoadjuvant chemoradiotherapy (nCRT)
  clinical response to, 304, 307, 308
  locally advanced rectal cancer, 347
  rectal cancer, 298, 304–307, 321
  timing of surgery, 308, 309
Neostigmine, 383, 384
Neurogenic retrorectal tumor, 285
Neurogenic lesions, 285
Nifedipine, 84
Nitrates/nitroglycerin (NTG), 84
NOD2/CARD15 gene, 529
Non-contact thermal electrocautery technique, 684
Non-healing perineal wounds (NHPW)
  comorbid conditions, 195
  digital rectal examination, 197
  fecal diversion, 197
  Fournier's gangrene, 196
  free flap closure, 198
  imaging, 197
  inflammation, 195
  local flaps, 198
  macrodebridement, 197
  malignancies, 196
  management algorithm, 196
  microdebridement, 197
  patient history, 195
  perianal surgery/APR, 196
  physical examination, 196
  radionecrosis, 195
  regional flap
    gracilis muscle flap, 198, 199
    VRAM, 198, 199
  treatment
    antimicrobial applications, 197
    direct primary closure for, 197
    moist wound dressings, 197
    NPWD, 197
    secondary intension, 197
  urology/gynecology, 197
Non-inflammatory diarrhea, 444
Non-mucinous adenocarcinoma, 521
Nonocclusive mesenteric ischemia (NOMI), 548, 549
Non-relaxing puborectalis (NRPR), 23
Nonsteroidal anti-inflammatory drug (NSAID), 725
Normal barrier function, 558
Normal epithelial barrier function, 558
Norovirus, 444
Nucleic acid amplification tests (NAATs), 183, 184, 424

O

Obstructed defecation syndrome, 20, 237
Occlusive mesenteric ischemia, 549
Octreotide, 601, 704
Ondansetron, 268
Ogilvie's syndrome, 366
  See also Acute colonic pseudo-obstruction (ACPO)
Oligometastatic synchronous liver disease, 514
Open-loop obstruction, 553
Opioid, 383
Opportunistic infection (OI), 444
Optimal pelvic floor biofeedback, 249
Optimizing the Surgical Treatment of Rectal Cancer (OSTRiCh) Consortium, 313
Oral doxycycline, 183
Organ Injury Scale, 393, 394, 396
Osmotic agents, 276
Osseous lesions, 285
Ostomy
  care and techniques, 612
  fecal incontinence, 262
    injectables, 262
    RF remodeling, 263
OverStitch™, 664
Over-the-scope-clip (OTSC), 664, 688
Ovesco OTSC System, 683
Oxaliplatin, 524

P

Paget's disease, 208, 210, 211
Panitumumab, 311
Paracolostomy hernias, 611
Paradoxical puborectalis contraction, 237
Paraffin anus, 89
Parastomal hernias, 607
  abdominal wall contouring, 615–617
  algorithm, 611–618
  asymptomatic patients, 612
  circumstomal approach, 618
  complications, 618
  endoscopy, 611
  extensive dense adhesions, 614
  imaging, 611, 612
  keyhole technique, 613, 614
  laboratory studies, 611
  late complications, 611
  local repair, 612, 613
  mechanical fixation device, 615
  Mercedes technique, 618, 620
  mesh placement, 613, 614
  open (modified Hasson) technique, 614
  peripheral tacking sutures, 614
  peritoneal stretching, 611
  physical examination, 611
  postoperative management, 618
  predisposing factors, 611
  recurrence rate, 619
  relocation, 615, 616
  sandwich technique, 614
  Sugarbaker method, 613–615
  surgical therapy, 611
  "suture passer" technique, 615
  wound ostomy care nurse, 612

Z-plasty technique, 618, 619
Parenteral antibiotic prophylaxis, 714, 715
Parenteral nutrition, 576, 577
Pedunculated polyps, 479, 688
Pelvic anastomotic leaks, 671, 672
Pelvic floor disorders, 20
Pelvic floor dysfunction (PFD), 245, 246, 265, 266
Pelvic floor dyssynergia, 237
Pelvic floor exercises, 268
Pelvic outlet obstruction, 237
algorithm, 238
anorectal physiology evaluation, 240
anoscopy, 240
balloon expulsion, 241
botulinum toxin A, 242, 243
colonic motility, evaluation of, 240
constipation, 238
defecography, 241, 242
diagnostic evaluation, 240
dietary changes, 242
elements, history, 240
EMG, 241
endoscopic evaluation, 240
history and physical exam, 238
in-office examination, 239, 240
intestinal stoma, 243
manometry, 241
pathologies, 238
pelvic floor musculature, 239
pelvic floor physical therapy, 242
pelvic floor, ultrasound of, 242
Sitzmark capsule, 241
symptoms, 237
transanal ultrasound, 241
treatment, 242
Pelvic recurrence, 332
Pelvic sepsis, 721, 722, 724
Peptide receptor radionuclide therapy (PRRT) strategy, 603
Percutaneous biopsy, 283
Percutaneous embolization, 633
Perforation, 689
clip placement, 689
colonic, 688
electrocautery, 688
electrocoagulative damage, 688
EMR *vs*. ESD, 688
incidence, 688
macro and micro perforation, 688
mortality rate, 688
OTSC, 689
partially/totally covered stents, 689
prevention, 691
risk factors, 688
Perianal abscess, 73
Perianal fistulizing disease, 89, 722, 725
Perianal/genital lesions, 183
Perianal sepsis, 98
Perianastomotic recurrences, 332
Perineal proctosigmoidectomy, 278
Perineal rectosigmoidectomy, 221, 222
Perinuclear antineutrophil cytoplasmic antibodies, 725
Perioperative assessment
anti-TNF agents, 43
CBC, 38
chest radiograph, 37
clinical history, 37
electrocardiogram, 37
fasting blood sugars, 43
patient risk assessment
ACS NSQIP, 42
APACHE II, 42
Apgar score, 42
ASA score, 40, 41
CPET, 40
Duke Activity Status Index, 39, 40
emergency surgery, 40, 41
E-PASS scoring system, 42
myocardial infarction, 40
POSSUM, 42
P-POSSUM, 42
RCRI, 41
routine exercise stress testing, 40
Surgical Risk Scale, 42
Surgical Risk Score, 42
physical examination, 37
platelet count, 38
pregnancy test, 39
PT/INR and PTT, 38
risk reduction strategies
aspirin, 43
CARP trial, 42
DAPT, 43
DECREASE V trial, 42
perioperative beta-blocker, 43
statins, 43
serum chemistry, 38
surgical procedure risk assessment, 39
treatment algorithm, 38
urinalysis, 38
Peristomal irritations, 637
Peristomal skin, 631
calamine lotion, 639
causes, 636
chemical peristomal irritation, 637
clinical indication, 635
denuded skin, 639
disease, 638
ill-fitting pouch, 639
infectious dermatitis, 638
light dusting powder, 639
mechanical peristomal injury, 637, 638
ostomy, 635
pre-existing medical conditions, 638
pressure ulcers, 639
skin sealant, 639
skin ulceration, 639
stoma creation, 636
stoma location, 635
symptoms, 636
Peritoneal cancer index (PCI), 517–519, 524
Peritoneal carcinomatosis (PC), 497, 515, 520

Peritonitis, 179, 180
Peri-wound skin care, 578
Peutz-Jeghers polyps, 453, 586
Peutz-Jeghers syndrome, 586, 587
Phlebotonics, 142
Physiological and Operative Score for the enUmeration of Mortality and Morbidity (POSSUM), 42
Pilonidal disease
  Bascom/cleft-lift technique, 155
  clinical presentation, 151
  excision and healing by secondary intention, 154
  excision and primary repair, 154
  hair removal, 152
  history, 151
  incidence, 151
  incision and drainage, 152
  Karydakis flap, 155
  phenol injection, 153
  rotational flaps
    Limberg/rhomboid flap, 156
    V-Y advancement flap, 156
  scimitar shape, distal incision, 155
Plastic wound protectors, 716
Pneumatic (balloon) dilatation, 678
Pneumatosis intestinalis, 547
POISE 2 trial, 43
Polymerase chain reaction (PCR) testing, 424
Polyps, 686
  size and location, 687
  thick stalk, 687
Polypectomy, 687
Portsmouth variation of POSSUM (P-POSSUM), 42
Positron emission tomography (PET), 344
Post polypectomy syndrome, 662
Posterior sling rectopexy, 224
Posterior tibial nerve stimulation (PTNS), 260
Postoperative ileus (POI), 52
Postoperative nausea and vomiting (PONV), 50
Post-polypectomy bleeding (PPB), 687, 688
  adrenaline (epinephrine) solution, 688
  adverse events, 687
  algorithm, 682
  bedside endoscopic intervention, 681
  cathartic effect, 682
  clipping, 688
  closure of perforations/fistulae, 683
  colonoscopic polypectomy, 681
  delayed bleeding, 684, 688
  delayed hemorrhage, 681
  detachable nylon loop ligation device, 688
  dilute epinephrine solution, 683
  electrocautery, 683
  emergent salvage surgery, 684
  endoscopic clipping, 683
  factors, 687
  immediate bleeding, 682
  intraprocedural bleeding rates, 687
  lifting technique, 688
  medical stabilization, 681
  Ovesco OTSC System, 683
  pedunculated polyps, 688
  prevention, 689, 690
  procedural bleeding, 682
  prophylactic use, 688
  pure cut/blend current, 687
  refractory bleeding, 684
  risk factors, 681, 687, 688
  thermal/mechanical hemostasis, 683
Post-polypectomy electrocoagulation syndrome, 689
Post-polypectomy thermal injury (PPTI)
  colonoscopy, 685
  complications, 685
  electrosurgical and electrocautery tools, 686–687
  electrosurgical currents, 685
  endoscopists, 685
  injury types, 688
    bleeding, 687–690
    perforation, 688, 689, 691
    post-polypectomy syndrome, 689
Pouch-anal sutured anastomosis, 115
Pouch endoscopy, 731
Pouch prolapse, 726
Pouchitis, 723, 725
  abdominal and pelvic imaging, 732
  antibiotic-dependent pouchitis, 732
  anti-tumor necrosis factor agents, 732
  classification, 731
  clinical presentation, 731
  diagnostic algorithm, 730
  diagnostic modality, 731
  etiology and pathogenesis, 729
  etiopathogenetic pathways, 729
  extraintestinal manifestations, 729
  genetic polymorphisms, 729
  immunomodulators, 732
  laboratory tests, 731
  long-term complication, 729
  mucosal biopsy, 731
  patient development, 732
  risk factors, 729
  treatment, 732
  treatment algorithm, 730
Pouchitis Disease Activity Index (PDAI), 725
Pouchoscopy, 731
Pouch sinus, 724
Pouch-vaginal fistula (PVF), 115, 119, 721, 724
Preanastomotic colon, 675
Prebiotics (inulin and fructo-oligosaccharide), 561
Prehabilitation, 47
Preoperative carbohydrate loading, 715, 716
Presacral bleeding
  algorithm, 695–697
  anastomotic disruption or pelvic sepsis, 695
  conventional hemostatic techniques, 695
  da Vinci® SI surgical robot, 697
  direct electrocoagulation, 697
  fenestrated bipolar electrocautery, 697
  incidence, 695
  massive, 695, 697
  metallic thumbtacks, 695, 696

presacral plexus, 696
presacral venous plexus, 695
rectal surgery, 695
resuscitation and planning, 697
robotic colorectal surgery, 697
sacral tacking, 695
topical hemostatic agents, 696
Presacral plexus, 696
Presacral venous plexus (PSVP), 695
Pressure ulcers, 639
Probiotics, 561
Proctitis, 59
Proctoscopy, 328, 344
Proctosigmoidoscopy, 9
Prolapsed internal hemorrhoids, 75
Prolonged bacterial translocation, 558
Prone/posterior (Kraske) approach, 286
Prophylactic inguinal lymphadenectomy, 216
Prophylactic ureteral catheters, 647
Proton beam therapy, 560
Proton Pump Inhibitors (PPI), 704
Pruritus, 59
Pruritus ani, 145
anal tattooing, 166
bacterial infections
Corynebacterium minutissimum, 161
gonococcal infection, 161, 162
syphilis, 161, 162
biopsy, 160
bowel habit, 159, 165
capsaicin, 166
colorectal and anal causes, 165
dermatologic conditions
atopic dermatitis, 164
contact dermatitis, 163, 165
lichen sclerosis, 163, 164
lichen simplex chronicus, 163, 164
psoriasis, 162, 164
diagnosis and treatment, 160
diet, 159
etiology, 160
food education, 165
fungal infections, 162
hygiene, 165
inciting factors, 165
initial evaluation, 166
local irritants, 159, 164, 165
past medical history, 159
physical examination, 159
pinworm infection, 162
systemic causes, 164
systemic signs, 159
tacrolimus, 166
toileting behavior and hygiene, 159
vicious cycle, 159, 160
viral infections
anal condylomata, 162, 163
HSV infection, 162, 163
Pseudomyxoma peritonei, 517, 519–521, 523, 524
Pseudo-obstruction, 363, 366
Psoriasis, 164
PTEN Hamartoma Tumor Syndrome (PHTS), 587
Puborectalis muscle, 16
Pudendal nerve terminal motor latency (PNTML/PTNML), 17, 266
Pure cut current, 685
Pursestring suture, 232
Pyoderma gangrenosum, 638

Q

QuickClip2, 664
QuickClipPro™, 664

R

Radiation enteropathy/enteritis, 700
Radiation-induced small bowel disease (RISBD)
acute enteritis, 564, 565
alpha-lipoic acid, 563
budesonide, 562
chronic
emergency GI hemorrhage, 567
enterocutaneous fistula, 569, 570
indications, 565
perforation, 568
preoperative surgical risk factors, 566
resection *vs*. intestinal by-pass, 565–566
small bowel obstruction, 568, 569
coniferyl aldehyde, 563
mechanism
acute intestinal injury, 557
chronic intestinal injury, 558
medical therapy, 561
mitigators/treatment agents, 562
radioprotectors, 561–562
radiation therapy
field size reduction, 559
IMRT, 559
interstitial/intra-cavitary brachytherapy, 560
multiple field arrangements, 559
patient positioning and positioning devices, 560
proton beam energy, 560
stereotactic radiation therapy, 560
3D conformal technique, 560
risk factors, 558, 559
surgical prophylactic techniques, 563, 564
Radiation-intestinal disease, 560
Radiation proctitis, 677
Radiation therapy, 346
Radiofrequency ablation (RFA), 338
Radioprotectors
amifostine (Ethyol), 561–562
prebiotics, 561
probiotics, 561
Sucralfate (aluminum sucrose octasulfate), 562
Radiotherapy, 337, 593
Raloxifene, 541
Rebleeding, 634
Rectal biopsy, 276

Rectal cancer
adjuvant chemotherapy, 309
algorithm, 290, 297, 298
APR, 301
cCR, non-operative strategy for, 323, 324
clinical assessment, 321
clinical/endoscopic findings, 321
clinical/pathological response, 324
complete clinical response, 321
CRT completion, timing of assessment after, 322
DRE, 321
endoscopic assessment, 321
endoscopic forceps' biopsies, 323
endoscopic view, 322
functional outcomes, 299
histologic features, 289
ileostomy reversal, 312
local excision, 290
anatomical considerations, 292, 294
transanal endoscopic microsurgery, 292, 293
transanal excision, 292
transanal minimally invasive surgery, 293, 294
local recurrences, 324
location of, 299
lymph node invasion, 290
lymph node metastasis incidence, 289, 290
magnetic resonance imaging, 322
MDTs, 312
metastatic rectal cancer, 309–312
minimally invasive techniques, 301
morphology, 289
MRI, 289, 323
neoadjuvant chemoradiotherapy, 298, 304–307, 321
clinical response to, 304, 307, 308
timing of surgery, 308, 309
patient positioning, 290, 291
PET/CT, 322
postoperative surveillance, 327–329
preoperative staging, 289
pre-treatment biopsies, 324
primary cancer, regression of, 323
reconstructive options, 300, 301
rectum, superior aspect of, 298
resection, distal margin of, 300
sphincter preservation, 301
sphincter-sparing operation, 300
staging, 303, 304, 309–312
surgery, oncologic principles of, 299
technical difficulties and risks, 300
TME dissection, 299
transanal endoscopic microsurgery, 294
transanal local excision/full excisional biopsy, 323
transanal minimally invasive surgery, 294
treatment options, 297
treatment protocol, 324
Watch and Wait Algorithm, 322
Rectal duplication cysts, 284
Rectal intussusception
asymptomatic, 231
internal, 229
multidisciplinary approach, 233, 234
multi-organ prolapse, 231
non-surgical measures, 231
surgical intervention, 231, 232
symptomatic, 229–231
transabdominal procedures, 233
Rectal irrigation per anus, 181, 182
Rectal outlet obstruction, 20
Rectal prolapse/recurrence, 5
abdominal approach, 223
algorithm, 220
anal encirclement, 223
anterior rectopexy, 225
anterior sling rectopexy, 224
epidemiology, 219
evaluation, 220, 221
hemorrhoid mucosal prolapse, 221
laparoscopic approach, 226
mucosal sleeve resection, 222, 223
perineal rectosigmoidectomy, 221, 222
physiology, 219
posterior sling rectopexy, 224
presentation, 220
recurrent rectal prolapse, 226
resection rectopexy, 224
suture rectopexy, 224
ventral rectopexy, 225
Rectal sleeve advancement flap, 115, 118
Rectiv®, 84
Recto anal inhibitory reflex (RAIR), 15, 21
Rectocele repair, 278
Rectopexy, 278
Rectosigmoid endometriosis, 403
Rectovaginal fistula (RVF), 5
anoplasty, 115
CT scan, 113
endoluminal ultrasound, 112
episioproctotomy, 115, 116
etiology, 111
examination under anesthesia, 113
fistulotomy, 113
ileoanal pouch-vaginal fistulas, 115, 119
initial treatment, 113
office evaluation, 111, 112
rectal sleeve advancement flap, 115, 118
redo colo-anal anastomosis, 121
surgical repair, 113
tissue advancement flap, 114, 115
tissue interposition, 120, 121
treatment algorithm, 112
vaginal approaches, 120
Recurrent colon cancer
adjuvant chemotherapy, 515
anastomotic recurrences, 514
ASCRS practice guidelines, 511
colonoscopy, 511
CRS, 515
CT/ultrasound-guided biopsies, 512
curative intent surgery, 514, 515
diagnosis, 512

EBRT, 514
HIPEC, 515
incidence, 511
intraoperative ultrasound, 514
IORT, 514
locoregional recurrence, 511, 516
palliative treatment, 512
PET scans, 512
postoperative chemotherapy, 514
preoperative chemotherapy, 513
preoperative planning, 514
randomized trials, 511
SEMS, 512
surgical oncologic principles, 514
symptoms, 511
ureteral stents, 514
Recurrent rectal cancer
chemotherapy, 337
CIRT, 337
colorectal surveillance guidelines, 334
distant recurrence, 332, 337, 338
extralevator APR versus conventional APR, 332
follow-up and initial assessment, 332–334
local recurrence, 332
classification, 334, 335
evaluation and planning, 336
surgical treatment, 336, 337
management algorithm, 333
metastatic disease, 331
radiotherapy, 337
risk factors associated with local recurrence, 331, 332
Redo colo-anal anastomosis, 121
Re-feeding enteroclysis, 576
Regional flaps, 198
Renzapride, 20
Reoperative pelvic surgery
algorithm, 735–739
anastomotic disruption, 735, 736
anastomotic leak, 735
bilateral ureteral stents, 737
clinical evaluation, 736
coloanal anastomosis, 739
colorectal anastomoses, 735
due to scarring and tissue fixation, 738
endoanal technique with pullthrough procedure, 738
history and physical examination, 736
mucosectomy, 738
optimization, 736
patient position, 739
preoperative assessment, 735
proximal diversion, 735
rectovaginal/rectourethral fistula, 738
step-by-step algorithm, 737
Turnbull-Cutait delayed coloanal anastomosis, 738
Resectable locoregional disease, 602
Resection rectopexy, 224
Resolution™, 664
Restorative proctocolectomy, 463
Retracted colostomy, 626, 627
Retracted ileostomy, 626
Retrorectal sarcomas, 283
Retrorectal tumors
abdominal approach, 288
adjuvant/neoadjuvant chemo and radiation, 288
algorithm, 281, 282
combined abdominal/posterior, 286–288
congenital, 283, 284
endoscopy, 282
epidermoid cyst, 283
history and physical examination, 281
imaging modalities, 281, 282
invasive chondrosarcoma, 286
miscellaneous, 286
neurogenic retrorectal tumor, 285
neurogenic, 285
osseous lesions, 285
percutaneous biopsy, 283
presentation, 281
prone/posterior (Kraske) approach, 286
sacral chordoma, 284
Revised Cardiac Risk Index (RCRI), 41
Rifaximin, 390
Right-sided diverticulitis, 358
Right ureter injury, 646
Rigid proctosigmoidoscopy, 5
Robotic colorectal surgery, 697
Rome III criteria, 18

S

Sacral chordoma, 284
Sacral nerve stimulation (SNS), 17, 258–260, 390
Sacral tacking, 695
Sandwich technique, 614
Sarcoma, 520
Sartorius scores, 172
Scimitar sign, 282
Scintigraphy, 19
SECCA procedure, 263, 268
Segmental reversal of the small bowel (SRSB), 706
Self-expanding metallic stents (SEMS), 357, 512
Sepsis control, 576
Sequential compression devices (SCD), 49
Serial transverse enteroplasty (STEP), 707
Serum Chromogranin A (CgA), 597
Sessile polyps
flat nature, 453
glandular serration, 452
hyperplastic polyps, 452
proliferation causes, 452–453
sessile serrated polyps, 452, 453
traditional serrated adenomas, 453
Sessile serrated polyps (SSPs), 452, 453
Sexually transmitted diseases (STDs), 74
asymptomatic high-risk patients, 183
chancroid, 185
chlamydia, 184, 185
gonorrhea, 183, 184
granuloma inguinale (donovanosis), 185
herpes simplex virus 1 and 2, 186

Sexually transmitted diseases (STDs) (*cont.*)
  HIV infection, 186
  human papillomavirus infection, 186, 187
  lymphogranuloma venereum, 185
  molluscum contagiosum, 187
  screening, 183
  symptomatic patients
    perianal/genital lesions, 183
    proctitis, 183
  syphilis, 185, 186
Short bowel syndrome (SBS)
  antisecretory medications, 704
  causes, 701
  clinical presentation, 699, 701
  clinical spectrum, 701
  controlled tissue expansion, 707
  with Crohn's disease, 699
  diagnosis, 702
  dilated small bowel, 707
  due to multiple laparotomies, 699
  enteral feeds, 704
  enterocutaneous fistula, 699
  enteroplasty, 706
  etiology, 701
  functional, 701
  growth factors, 705
  ICV, 701
  immediate treatment, 703
  inhibitory feedback mechanism, 701
  intermediate/long-term treatment, 703
  intestinal adaptation and rehabilitation, 705
  intestinal failure, 699
  intestinal transplant, 707
  isoperistaltic colonic interposition, 706
  jejunostomy patients, 702
  jejunum-colon anastomosis, 701
  Jejunum-ileum patients, 702
  laparotomy, 701
  longitudinal intestinal lengthening and tailoring, 706
  management, 702, 703
  mesenteric ischemia, 700
  non-transplant surgical options, 705
  post-operative management, 701
  radiation enteropathy, or enteritis, 700
  risk factors and clinical presentation, 700
  serial transverse enteroplasty, 707
  small intestinal bacterial overgrowth, 701
  surgical intervention, 705
  surgical management, 705, 706
  total parenteral nutrition, 703
  TPN failure, 707
  tubularized bowel, 707
Short course radiotherapy (SCRT), 306, 318
Short form 36 (SF-36), 705
Short gut syndrome, *see* Short bowel syndrome (SBS)
Side-to-side isoperistaltic strictureplasty (Michelassi procedure), 535, 536
Sigmoid colon, 367
Sigmoid volvulus, 367–369
  elective/semi-elective, 372
  endoscopic detorsion of, 371, 372
  mesosigmoidoplasty, 370
Sigmoidoscopy, 282
Silver sulfadiazine, 163
Simple anorectal fistula, 127
Single Incision Laparoscopic Surgery (SILS), 499
Single perianal fistula, 125
Sinus tracts
  algorithm, 676
  asymptomatic, 677
  diverting stoma, 675, 677, 679
  incidence, 675
  management, 678
  multiple anastomotic, 679
  pathophysiology, 675
Sitzmark capsule, 240, 241
Skin tags, 145, 146, 148, 149
Slow transit constipation, 277
Small bowel adenocarcinoma, 587
Small bowel and appendiceal endometriosis, 402
Small bowel carcinoids, 596, 598
Small bowel hemorrhage, 567
Small bowel lymphoma, 588
  algorithm, 591, 592
  clinical manifestations, 591
  clinical outcomes, 593
  diagnosis, 592
  EATL, 591
  immunoproliferative small intestinal disease, 591
  laboratory evaluation, 592
  palliative surgery, 593
  prognosis, 593
  systemic evaluation, 592
  treatment strategy, 593
Small bowel obstruction (SBO), 568, 569
  adhesions, 553
  algorithm, 551–556
  clinical presentation, 551
  closed-loop obstruction, 553
  complete/high-grade, 553
  conservative management, 554
  endoscopy, 552
  etiology, 554
  hernias, 553
  history and physical examination, 551
  intraoperative strategies, 555
  laboratory tests, 552
  laparoscopic management, 555
  malignancy, 554
  partial/low-grade, 553
  radiology, 552
  strangulation, 553
  surgical intervention, 554–555
  surgical palliation, 555
Small bowel ostomies, 635
Small bowel polyps
  algorithm, 584
  bleeding, 583
  carcinoids, 587, 588
  clinical presentation, 583
  Crohn's disease, 588
  CT and MRI enterography, 584

double balloon or push enteroscopy, 584
duodenal polyps, 585
endoscopic removal, 588, 589
endoscopic surveillance, 585
family/personal history, 583
histologic types, 583
HNPCC, 585
intussusception, 583
Juvenile Polyposis syndrome, 587
Lynch syndrome, 585
MutYH-associated polyposis, 585
obstruction, 583
Peutz-Jeghers syndrome, 586
pill camera endoscopy, 584
PTEN Hamartoma Tumor Syndrome, 587
small bowel adenocarcinoma, 587
small bowel-follow through/enteroclysis, 584
small bowel lymphoma, 588
small bowel polyp, 586
Spigelman criteria, 585
spontaneous, 584
treatment, 588
Small intestinal bacterial overgrowth (SIBO), 701, 731
Somatostatin, 524
Somatostatin analogues (SSA), 601
Somatostatin receptor scintigraphy (SRS), 598
Sphincter injury, 258
Sphincteroplasty, 258, 259
Sphincter replacement, 261, 262
Sphincter-sparing operation, 300
Sphincter-sparing procedures, 105–107
Spigelman criteria, 462, 585
Splenic flexure mobilization, 654
Squamous cell carcinoma (SCC), 172, 209, 210, 213, 214
SRUS, 230
Stage IV rectal cancer, 315
algorithm, 316
borderline resectable/unresectable hepatic disease, 318
diagnosis, 315
endoscopic stenting, 317
FOLFOX chemotherapy, 319
laboratory investigations, 315
liver-first strategy, 319
locally advanced primary tumors, 318
pelvic radiotherapy, 319
PROSPECT trial, 319
resectable and rectal primary tumor, 317
SCR, 318
survival rate, 320
synchronous hepatic metastases, optimal treatment for, 317
treatment, 315
Staphylococcus, 189
Staphylococcus aureus, 189, 191
Stapled hemorrhoidopexy, 143
Stapled transanal rectal resection (STARR) procedure, 231, 278
Stapling techniques, 609
Stereotactic radiation therapy, 560
Stimulants, 277
Stomal prolapse
algorithm, 607–610
full thickness stomal prolapse, 609
full thickness stromal prolapse, 607
incarceration, 610
incidence, 607
intra-abdominal contamination, 610
loop stomal prolapse, 607, 609
management, 609
necrotic prolapsed stoma, 607, 609
parastomal hernias, 607
risk factors, 607
stapling techniques, 609
surgical approaches, 610
two finger approach, 607
ulceration, 607, 609
Stomal re-siting, 633
Stomal reversal, 635
Stomal stenosis and retraction
causes, 624
definition, 623, 624
impact of, 623
inflammatory bowel disease/recurrence of malignancy, 623
laparoscopic surgery, 627
management, 627
postoperative weight gain, 623
prevention, 624, 625
relocation, 627
retracted colostomy, 626, 627
retracted ileostomy, 626
root cause, 623
surgical factors, 623
symptoms, 624
Stomal varices
acute bleeding, 631, 632
clinical presentation, 630, 631
endovascular interventions, 633
epidemiology, 630
etiology, 629
history, 629, 631
imaging, 631
laboratory tests, 631
mucocutaneous disconnection, 633
patient's degree of global dysfunction, 631
percutaneous interventions, 632
peristomal skin, 631
physical examination, 631
portal hypertension, 633
recurrent bleeding
beta-blockade, 632
pouching issues, 632
stoma's utility, 632
treatment, 632
variceal hemorrhage, 632
reducing portal hypertension
surgical shunts, 633
transjugular intrahepatic portosystemic shunt, 633
stomal re-siting, 633
Stomal varix, 629
Stool DNA tests, 9

Streptococcus, 189
Strictureplasty, 534
Stricturoplasty, 379
Subclinical leaks, 667
Subjective Global Assessment (SGA), 46
Subserosal lymphatics, 599
Subtotal colectomy with end ileostomy (SC+I), 427
Sucralfate (aluminum sucrose octasulfate), 562
Sudeck's point, 489
Sugarbaker method, 613–615
Supralevator abscesses, 98
Suprasphincteric fistula, 103, 104, 106, 126, 127
Surgeon Adjustment Score, 42
Surgical anal canal, 213
Surgical Care Improvement Project (SCIP) guidelines, 49
Surgical Mortality Probability Model (S-MPM), 41
Surgical prophylactic techniques, 563, 564
Surgical Risk Scale, 42
Surgical Risk Score, 42
Surgical site infections (SSI)
  anesthesia-related factors, 716
  assessment and prevention, 711, 712
  chlorhexidine *vs*. povidone-iodine, 714
  clipping *vs*. shaving hair removal, 715
  definitions, 711
  dressing care, 716, 717
  mechanical bowel preparation, 715
  oral antibiotics, 715
  parenteral antibiotic prophylaxis, 714, 715
  patient and operative risk factors, 714
  preoperative carbohydrate loading, 715, 716
  reimbursement penalty, 711
  risk factors, 714
  typical bundle, 717
  wound classification, 714
  wound closure, 716
  wound protectors, 716
Suspicious lymph nodes, 209
Suture rectopexy, 224
Symptomatic internal fistulas, 532–533
Symptomatic intussusception, 229–231
Syphilis, 162, 185, 186

T
Tacrolimus, 162, 166
Tailgut cysts, 284
Tamoxifen, 541
Tegaserod, 20
Tension-free anastomosis, 720
Teratomas, 284
Thermal injury, 661
Thick polyp stalk, 687
Thiersch procedure, 223
3D conformal technique, 560
Thrombosed external hemorrhoids, 145–148
Tibial nerve stimulation, 17, 260
Tincture of Opium, 268
Tissue interposition, 120, 121
Total abdominal colectomy (TAC), 409
Total abdominal hysterectomy (TAH), 474
Total abdominal/subtotal colectomy + end ileostomy, 427
Total mesorectal excision (TME), 331
Total parenteral nutrition (TPN), 577, 703
Toxic colitis (TC)
  antibiotic therapy, 425
  DLI + ICL, 427
  endoscopy, 425
  imaging, 424, 425
  IV antibiotics, 426
  IV cyclosporine/biologic agents, 426
  intravenous steroids, 426
  laboratory testing, 424
  medical management, 425
  risk assessment, 426
  segmental colectomy, 427
  surgical management, 427
  total abdominal/subtotal colectomy + end ileostomy, 427, 428
  Turnbull-Blowhole colostomy, 427
Traditional serrated adenomas (TSA), 453
Transabdominal/transanal purse-string, 721
Transanal endoscopic microsurgery (TEMS), 292, 293, 485
Transanal excision (TAE), 292
Transanal minimally invasive surgery (TAMIS), 293, 294, 485
Transanal mucosectomy, 115, 726
Transanal repair of rectocele and rectal mucosectomy with one circular stapler (TRREMS), 232
Transanal ultrasound, 241
Transjugular intrahepatic portosystemic shunt (TIPS), 633
Translocation technique, 616
Transsphincteric fistulas, 103
Transsphincteric fistula, 129, 131
Transureteroureterostomy, 648
Trephine stomas, 607
Treponema pallidum, 74, 162, 185
Trimethoprim/sulfamethoxazole, 186
Tubular adenomas, 451
Tubulovillous adenomas, 452
Turcot syndrome, 463
Turnbull-Blowhole colostomy, 412, 427
Turnbull-Cutait abdominoperineal pull-through, 121, 122
Turnbull-Cutait delayed coloanal anastomosis, 738
Typical fissure, 81

U
Ulcerative colitis (UC), 111, 423
  clinical presentation, 405
  colonic stricture, 378
  complications
    anastomotic strictures, 413, 414
    fistula formation, 414
    incontinence, 413
    pelvic sepsis, 413
    pouchitis, 414

sexual complications, 414
small bowel obstruction, 413
continent ileostomy, 414
continent reconstruction, 412, 413
daily management, 405
diagnostic labs, 406
dysplasia management, 407, 408
elective operation (*see* Ileal pouch-anal anastomosis (IPAA))
emergent operations, 409
endoscopy, 407
epidemiology, 405
etiology, 405
extracolonic manifestations, 407
incidence, 405
IRA, 415
long-term patient satisfaction, 414
medical management, 408, 409
operative management algorithm, 406
prevalence, 405
radiologic evidence, 405
stoma complications, 414
surgical indications, 409
surveillance, 407
TAC, 409
total proctocolectomy with end ileostomy, 412
Turnbull ‘Blowhole’ procedure, 412
Unfractionated heparin, 49
Univariate regression analysis, 653
Unresectable metastatic disease, 603
Ureteral catheterization, 647
Ureteral repair, 648
Urinary diversion, 648
US Multi-Society Taskforce, 472

V
Vaginal advancement flaps, 120
Vagotomy, 59
Variceal hemorrhage, 630, 632
Vascular outflow obstruction, 548
Vaseline, 164
Venous thromboembolism prophylaxis, 49, 50
Venous thrombosis, 550
Ventral rectopexy, 225
Verrucous carcinomas, 211
Vertical rectus abdominis myocutaneous flap (VRAM), 198, 199
Video-assisted anal fistula treatment (VAAFT), 131
Villous adenomas, 451, 452
Vinblastine, 541
Volvulus, 367
cecopexy, 371
colonic, 368
diagnosis, 368
incidence, 367
initial assessment, 368
non-resective and non-operative approaches, 372
operative interventions, 369, 370
sigmoid, 367–369
elective/semi-elective, 372
endoscopic detorsion, 371, 372
mesosigmoidoplasty, 370
surgical intervention, 370, 371

W
Waldeyer’s fascia, 298
Warts, 59
Western hemisphere, 377, 378
World Council of Enterostomal Therapists (WCET), 636
World health organization (WHO) grading system, 598
Wound closure, 716
Wound manager, 578
Wound ostomy care nurse (WOCN), 612, 636
Wound protectors, 716

X
X-rays, 240

Z
Z-plasty technique, 618, 619